Official Report

On Fruit Fly and other PESTS

In various Countries

1907-8

W.W. Froggatt


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DEPARTMENT OF AGRICULTURE.

REPORT

ON

PARASITIC AND INJURIOUS INSECTS.

BY

WALTER W. FROGGATT,
ENTOMOLOGIST.

1907-1908.

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Entomological Branch,
Department of Agriculture,
9th March, 1909.

To the Hon. John Perry,
Minister for Agriculture.

Sir,

I have the honor to herewith furnish this report upon my investigations into entomological questions, carried out with the permission of the Government of New South Wales for the Governments of Victoria, South Australia, and Queensland, as well as this State, between the 7th July, 1907, and the 30th July, 1908.

Furnished with credentials from the Australian States I represented, I was enabled to see the inner working of the Departments of Agriculture, Scientific Institutions, &c., visited in the different countries.

In every country I met with unfailing kindness and courtesy from Government officials, scientific workers, British consuls, and many strangers.

Everywhere I was complimented upon the enterprise shown by the Australian States in sending out a commission of investigation to obtain, first hand, information upon questions of such vital importance to the producers of Australia.

I have the honor to be,
Sir,
Your obedient Servant,
WALTER W. FROGGATT,
Government Entomologist, N.S.W.

INDEX.

PARASITIC AND INJURIOUS INSECTS.

Report of Walter W. Froggatt, Entomologist to the Department of Agriculture of the State of New South Wales, and Investigating Entomologist for the States of Victoria, South Australia, and Queensland, during his study of Parasitic and Injurious Insects in various parts of the world in 1907–1908.

PART I.

General Report.

(1) The commercial value of introduced Parasites to deal with insects that are pests.

(2) The range and spread of Fruit-flies and the methods adopted in other countries to check them.

(3) The value of Parasites in exterminating Fruit-flies.

(4) Habits of cosmopolitan Insect Pests.

A CONFERENCE of Government Entomologists was held in Sydney on the 9th of July, 1906, at which the question of parasites as effective checks to injurious insects was considered, and an offer made by the Commissioner of the State Board of Horticulture of California to several of the Australian States, to supply them each with a goodly collection of the parasite of Codling Moth for the sum of £1,000.

A motion was put on the "expediency of personal inquiry as regards parasites in California," which was followed by another, "That this Conference, having taken into consideration the importance attaching to the proposed undertaking contemplated in the preceding motion, is of opinion that the Government Entomologist of New South Wales, possessing the special high attainments needed for the inquiry, be delegated to prosecute the same."

Nothing further was done in the matter until June, 1907, when, at the Conference of State Premiers, held in Brisbane, the Acting Premier of Victoria, Mr. Swinburne, tabled a motion, "That, in consequence of the increase of Fruit-fly and other pests, with the permission of New South Wales, their Entomologist be despatched to America and Europe to inquire into the best methods of dealing with Fruit-flies and other pests; the value

of parasites; to procure and despatch same if effective." The representatives of Queensland, South Australia, and New South Wales agreed to this, and that the expenses should be shared by the four States.

The scope of the investigations was considerably enlarged before I started. Queensland suggested that I should visit India and Ceylon, in order to see the species of fruit-flies allied to that known as the Queensland Fruit-fly; and my instructions were to go to those places where pests could be best studied, and information obtained on entomological subjects. Furnished with credentials from each of the four States represented, I left Sydney on 8th July for San Francisco, *vid* Hawaii.

Honolulu was reached on the 14th of July, where I remained for three weeks. During that time I placed myself, first, in the hands of the Federal Department of Agriculture; Mr. Jared Smith is Director, and Mr. Van Dine, Entomologist; and most of my official work was done at the Experiment Station, with the assistance of these gentlemen.

Besides the United States Department of Agriculture, there are at Honolulu two other institutions at which entomological work is carried out—the experiment station of the Hawaiian Sugar Planters' Association, where, under the director, Mr. R. C. L. Perkins, there are six other entomologists in the Entomological Division. The staff carry out investigations in the control of the pests of sugar-cane, and, therefore, do not pay any attention to fruit-flies or orchard pests. Messrs. Perkins and Kirkaldy have been for some time describing new species of all kinds of insects, which in many cases have little to do with economic entomology or pests of sugar-cane, though they form a fine set of monographs of the insects dealt with, obtained by their collectors.

It is under the direction of this Experiment Station that some daring experiments have been made in economic entomology. Among these may be instanced the introduction of *foreign pest insects* to destroy introduced injurious vegetation. Much of the waste land of the Hawaiian Islands, denuded of its indigenous forest flora at a very early date, is now overrun with a low scrub of lantana, guava, and a prickly acacia. The planters claimed that it was too expensive to clear these lands of lantana, and Mr. Koebele spent a season in Mexico, collecting any insects breeding in or upon lantana. He sent over several microlepidoptera and small butterflies, whose caterpillars feed upon the flowers, foliage, and seeds; a gall-making fly (*Entreta sparsa*, Wied.); a leaf-mining fly (*Litho-colletis*, sp.); a defoliating leaf bug (*Teleonemia scrupulosa*), and moth and beetle larvæ to devour the roots of the unfortunate plant. It was claimed that within about two years the lantana had not only been checked by the destruction of its seeds, but that it was dying out in large areas all over the islands. I examined a great deal of this scrub on the slopes of Mount Tantilus, and other places on which these pests had been liberated, and though the seeds were not so plentiful as upon the other side of the island, none of the plants were dead. However, upon the poorer land some plants had lost a good many leaves through the action of the plant bugs.

The Mealy Bug pest (*Orthesia insignis*), one of the most injurious pests to the tea plant in Ceylon, was accidentally introduced into the island of Maui, and is commonly known as the "Maui blight." It is the most destructive insect to the lantana. Though accidentally introduced originally, it has been purposely scattered over the islands by the planters, and may some day become a very serious pest to cultivated plants. Whatever may be said in favour of introducing insect parasites to destroy injurious insects, nothing,

even if successful, can be said in favour of knowingly introducing plant-eating insects and their larvæ, for no one can tell what such insects may do when their own food-plant is finished.

This Association has sent officers all over the world to collect and send back parasites of all kinds, and according to the reports that have been furnished to the public, there should now be no scale insects or other pests in the Hawaiian Islands. Yet I found as many scale-insects upon their cultivated plants as would be found in Australia, and also many cosmopolitan pests, such as Fuller's rose beetle (*Aramigus fullēri*). This is a small weevil from the United States, where it is the greatest garden pest that rose-growers have to deal with; it also defoliates many other plants. Then there is the "Japanese Leaf-beetle" (*Adoretus umbrosus*), a small lamellicorn that is very destructive to all kinds of foliage. They also have the Melon Fly (*Dacus cucurbitæ*), introduced from India, which destroys melons; it will be noted further on in this report. The Yellow Fever Mosquito (*Stegomyia fasciata*) is another introduced pest; while they have also one of the worst of blood-sucking flies in the "Horn Fly," so called because Professor Riley, in one of his reports, figured them clustering round the base of a bullock's horn, a place, by-the-way, where they are seldom found; but they swarm over the sides and flanks of the unfortunate cattle, and give them no rest, and are just as numerous in the dairy as in the paddock. On the island of Molokai they not only worried the cattle, but settled upon the open sores on the sheep that were infested with scab, and prevented these healing.

In fact, it would be as difficult to enumerate all the pests that have been accidentally introduced from abroad as it would be to list the purposely introduced more or less useful insects that now form the bulk of the insect fauna of the islands. Even most of the birds commonly met with are introduced, and mostly pests; such as the Rice Bird (*Munia risoria*, var. *punctata*), and the Indian minah (*Acridotheres tristis*).

There is an introduced rat that damages the sugar-cane, and the mongoose was introduced from India to destroy it; but the mongoose has, contrary to expectations, destroyed most of the ground-nesting fauna on the islands except rats, and no one now can keep poultry in the immediate vicinity of Honolulu except in closely-netted yards.

Last year, the Sugar Planters' Association sent Mr. Muir out to India and the Malay States looking for a parasite for the cane weevil (*Sphenoporus obscurus*), introduced from Tahiti in banana stems over forty years ago. Professor Koebele was in Mexico looking for parasites of the cane-hoppers.

One of the greatest successes of the Association was the introduction of a parasitic wasp that destroys the eggs of the very destructive cane-leaf hopper (*Perkinsella saccharicida*). This hopper was introduced into their cane-fields about 1902, and caused an immense amount of harm, by depositing its eggs in the midrib of the leaves and sucking the sap out of the stems, causing injuries that produced a great deal of smut upon the surface. This caused a great loss where the fields were badly infested; and Professors Koebele and Perkins came over to Queensland in 1904, and spent some months collecting parasites in the northern cane-fields, from whence the hopper had probably been brought. Koebele sent back quantities of several species, one of which became established in the experimental cane growing round their laboratories, and from there was scattered all over the island. When I was there last year (1907) there were plenty of hoppers in the different fields we visited; but there were also many eggs in the midrib of the leaves, some with parasites and just as many uninfested. So rapid, however, was the spread of this egg parasite over the islands in about two years, that one would almost think

the parasite had been accidentally introduced with the cane-hoppers in the first instance, and had only made its appearance evident after the artificial introduction. This, however, would not lessen the credit that attaches to Koebele's work.

Another thing they do not take into account is, that when the leaf-hopper damage became acute, the methods of cultivating the cane were altered in many places; the refuse (probably containing many eggs and larvæ) was burnt instead of being buried, and new varieties of cane, with more resistant powers to the attacks of the leaf-hoppers, were grown in the infested fields.

Before we finish with this insect problem, I would point out that these leaf-hoppers must still exist in considerable numbers; so much so, that when the Pure Foods Act came into operation in the United States, just before I arrived at the islands, it was stated that some of the Hawaiian honey was not up to the standard demanded by the chemists. This was a very serious matter to the ranchmen, for nearly all of them ran apiaries on their estates, particularly the American Sugar Company, who have an estate of 95,000 acres on the island of Molokai, where they have some thousands of hives. The chief flowers from which the honey is obtained are those of the algeroba tree, which form great thickets all round the coasts and in the valleys between the mountains. This tree (*Prosopis juliflora*), said to have been introduced from Mexico, is identical, or closely allied to the species of this genus known as the "Mesquite," and bears a great crop of slender beans that are very good cattle and horse food.

This is known as "Algeroba Honey"; but about two-thirds of the crop is an abnormal dark production, which is now known as "Honey-dew Honey." This is produced by the bees collecting the honey-dew exuded by the swarms of leaf-hoppers and aphis in the cane-fields. Van Dine says (Bulletin 17, 1908): "The increase in the production of Hawaiian honey of recent years corresponds with the advent of the introduced sugar-cane leaf-hopper into the cane-fields, and the present extension of the business is in the vicinity of the immense areas of land given to cane-culture."

The officers of the Sugar Planters' Experiment Station may have had other successful introductions, such as ladybird beetles, to eat up mealy bug and other scale; but many of the ladybird beetles have in turn died out, while scale is quite common on trees and plants.

The third institution that keeps a staff of trained entomologists is the Board of Commissioners of Agriculture and Forestry, of which Mr. Alexander Craw is the Superintendent Entomologist; Mr. Koebele is Consulting Entomologist; and Mr. Kotinsky is in charge of laboratories and field entomology. The staff of this Territorial Department examine all products coming into the island, and fumigate or destroy all plants, flour, grain, &c., which may introduce pests.

There are altogether nine working entomologists, without counting inspectors, in the Hawaiian group.

The chief industries in Hawaii are sugar, pine-apples, and rice. Regular orchards, in our sense of the word, do not exist, with the exception of Mr. Dames' beautiful grounds at Moanalua, where all kinds of tropical fruits and flowers are grown. All the lands that will grow cane are scientifically cultivated, and a considerable amount is under irrigation, so that a very high percentage of sugar is obtained. Last year the islands produced 137,750 tons of sugar. The whole of both field and mill labour is carried out by Japanese coolies, both men and women working in the fields, and at Waialua Sugar Mill, near Haleiwa, the only white men we met were the chief chemist and an assistant; all the other employees were Japanese.

[*Photo. by D. L. van Dine.*

Japanese Packing White Honey (Algeroba Honey) at the American Sugar Company's Ranch, Island of Molokai, Hawaii.

The pine-apple industry is chiefly carried on at Wahiawa, where, at an elevation of about 1,000 feet, a tract of country is irrigated and homesteaded by Californians; here 2,000 acres of pine-apples are grown, and the estimated output in sight last year was 500,000 cases of canned pines, each containing 2 dozen tins, of an average weight of 2½ lb. per tin. There are three other canneries in the islands, one at Hilo, another at Kaiku, and a third at Kealia (Kauai Island). Here the labour is all Japanese, under white supervision.

The plants are grown in rows of different distances apart—those for canning usually 2 feet; those for export in double rows with 2 feet on either side. The land is ploughed before planting, and kept clean with the cultivator, and the climate is so wet that no irrigation is required for their growth.

The Director of the Experimental Station has had a number of shipments of fresh pine-apples sent *vid* San Francisco to try the Eastern markets; but though the distance is not great, they ripen so rapidly that the profit is very uncertain. Their worst disease, that probably has something to do with their decay, is a fungus that attacks them at the base, known as *Thielaviopsis ethaceticus*. Few insect pests are found upon the pine apple; *Diaspis bromeliæ* is a common but not serious pest on the leaves, and *Pseudococcus citri* is a mealy bug collecting round the base of the fruit.

At the Bureau of Agriculture and Forestry I went over the collections with Messrs. Craw and Kotinsky, particularly the coccids, which are mounted dry in glass tubes, and comprise a fine lot of specimens, among which are many collected by Professor Koebele. Here, also, I attended a meeting of the Entomological Society of Honolulu, and gave the members a short address upon our work in Australia.

Several days were spent on the island of Molokai, with Mr. Van Dine, investigating the stock diseases there, particularly the blow-fly pest on sheep which damaged the sheep by blowing the damp wool in the same manner as they do in Australia. Van Dine has since written a bulletin on this pest, which has been identified as *Calliphora dux*. Here we also found the bot-flies very common, and the shoulders of the horses running in the paddocks were covered with their eggs.

The United States.—San Francisco was reached on the 21st of August, and I immediately went round to the office of the State Board of Horticulture, at the Ferry Buildings. Here I met Mr. Bremner, who was in charge; I explained my mission to him, that I had come to see all that they could show me.

So much has been said and written about their insectarium and parasite breeding cages, that I had expected to see some large rooms, if not a piece of land, fitted up with all modern appliances. Instead of this, the insectarium is a small room, about 15 by 13 feet, adjoining the main office. About half a dozen ordinary breeding cages of wood, glass, wire, and gauze contain scale insects, ladybird beetles, and the celebrated codling moth apple parasite. These latter were enclosed in a breeding cage in which were several stacks of little bundles of laths so tied together that the liberated codling moth grubs, received from the apple-growers in large quantities for food for the parasites, could crawl in between the little laths and pupate, where they were exposed to the attacks of the large black ichneumon parasite (*Calliephialtes messor*). There were a great number of these handsome black wasps crawling about over the walls of the breeding cage; now and then they turned their attention to codling moth pupæ, and curved their ovipositor round and deposited their eggs in the hapless grubs. Many of the enclosed parasites had been bred out from

earlier-infested pupæ during the last few days; and while I was in the office, Mr. Carnes, who had them under his charge, sent away a number of packages to apple-growers who had applied for them for liberation in their orchards.

This is the parasite obtained about two years before from the north of Spain by the entomologist of Western Australia; it was figured and described all over the world as the parasite that would, in a few years, wipe out the codling moth in every country where it was properly introduced. It was claimed that there was no codling moth in Spanish apple orchards. In reference to apple orchards in Spain, I might state that on asking information of Professor D. L. Navarro, Director of Agriculture and in charge of Experimental Stations at Madrid, he said that all the apple orchards in Spain were of very small extent, chiefly confined to the north and north-west districts; and instead of being free from codling moth, there was hardly a sound apple in one of them. There was no export of apples, and the bulk of them were used for cider, so that it did not matter much if they were grubby. He had never heard of a parasite having the least effect upon them. This display of codling moth parasites in the cages was very interesting from an entomological point of view; but when it came to the question of where these same parasites could be found looking for codling moth in the apple orchards none of the officers could tell me. Accompanied by Professor Woodworth, of the University of California, I afterwards went over the great apple orchards of Watsonville and the Pajaro Valley, where there was plenty of codling moth, and where a great number of these parasites had been liberated. Neither the County Entomologist (Mr. Volck) or any of the orchardists had ever seen a codling moth parasite in the orchards. Mr. C. H. Rogers, the County Horticultural Commissioner, told us that they had sent many thousands of codling moth grubs to the office at San Francisco to rear up the parasites.

The conditions of codling moth in Pajaro Valley are somewhat interesting, and a large series of experiments have been carried out. The lower part of the valley, which lies behind the Bay of Monterey, is very subject to fogs, which makes spraying difficult, because the fog forms moisture on the fruit and foliage that dissolves the arsenic and causes it to burn the foliage; but at the same time the action of the fog also keeps the eggs of the codling moth from sticking to the damp surface of the fruit, so that the damage from moth is slight. The higher the altitude in the valley the worse the moth; and if unsprayed, 75 per cent. of the fruit is damaged. Most of the orchards on the hillsides are sprayed from three to five times in the season with arsenate of lead, and under these conditions no bandaging is done. Mr. Luther sold 30,000 lb. of arsenate of lead last season to these apple-growers, and he thought about 3,000 lb. more had been sold by the small dealers. One and a half million dollars' worth of apples were grown and sent from this valley last year.

The next place I visited to inquire into the codling moth parasite was at Sacramento. Here Mr. J. Isaacs, the Horticultural Commissioner, said he had liberated a great number of the ichneumon wasps, but had only seen one specimen at large since they had been turned out. We went all over the old garden round his house, but though on the old apple-trees there were any number of codling moth grubs, we found no codling moth parasite.

Mr. Ehrhorn, the very able entomologist in charge at the Horticultural Commissioner's office at San Francisco, could not tell me of any other place to visit, and this was all they knew of the Spanish codling moth parasite. Yet, in the last Annual Report of the New Zealand Department of Agriculture, 1907, Mr. Kirk says, "that they sent codling moth grubs from New Zealand to

California to feed the parasites. In exchange for this assistance the President of the State Board of Agriculture promised a colony of parasites. As the Board has been requiring £1,000 from each country desiring parasites, the gift was an extremely generous one, and the thanks of the Colony are due to Mr. Elwood Cooper, the President, and the Horticultural Board for the gift."

In Mr. Boucher's report, on his return to New Zealand with the colony of parasites, it is stated, "a number of parasites were liberated in an orchard in Sonoma County last season. This orchard had not been sprayed for some time, and the moth was rife—in fact, I was informed that the percentage of clean fruit was nil; yet during the season following the liberation of the parasites there was an appreciable percentage of fruit free from the moth. This season, it was reported to the State Board of Horticulture that the parasites were present in the orchard in large numbers, and investigation proved that the report was correct."

Now, I was in California a year later than Mr. Boucher's report, but none of the officers of the State Board of Horticulture could tell me anything about this orchard or show me parasites in the orchards in any part of California. Mr. Boucher's information was evidently second-hand. I can unhesitatingly state that no parasite of the size of this parasite is of any commercial value to the orchardist in checking codling moth. It is so big that every insectivorous bird can capture it; and so slow that it gives the birds all kinds of chances; and lastly, it has done no good in its native European home.

The value of introduced parasites in California has had a very fair test, for it commenced about twenty years ago, when our ladybird beetle was introduced into southern California to destroy *Icerya purchasi*. If everything were true that has been published by the Press and in the reports of the State Horticultural Commissioners since that date, of the value of the wholesale importation of useful insects to combat existing or introduced pests, there should now be no need for spraying, fumigation, or even the existence of the Commissioners, except as port inspectors.

The State Board of Horticulture consists of nine members, who are appointed by the Governor, two from the State at large, and one from each of the seven horticultural districts. The members must be residents of their respective districts and specially qualified by practical experience in horticulture; and each holds office for a term of four years. One of its members is treasurer, but the secretary is appointed from outside; they also appoint one of themselves, or someone outside, as inspector of fruit pests, to hold office at the pleasure of the Board. The money, 5,000 dollars a year, for the carrying out of the provisions of the Act is paid out of the State Treasury.

The Act that created this Board was called "An Act to create and establish a State Board of Horticulture, and appropriate money for the expenses thereof." Approved March 13th, 1883.

Two years before this the County Board of Commissioners came into existence by "An Act to protect and promote the Horticultural interests of the State" (March 14, 1881). Both these Acts have undergone considerable changes during the last twenty years. The powers given under these two Acts are very drastic, and the State Commissioners can do almost anything in orchards and gardens. At the request of twenty-five orchardists, the Supervisors (County Councillors) can appoint County Horticultural Commissioners, who can frame laws dealing with all insect pests; appoint inspectors, who have power to direct anyone to destroy plants or trees infested with pests, and if they do not comply, can do the work and charge it to the land-

holder, and recover the expenses, even to selling the place. Some of the County Commissioners have as many as 40 to 100 fumigating tents, and they fumigate the trees twice a year; from 50 to 70 tons of cyanide are used every season in southern California, while spraying outfits are always going.

As a general rule, they do not fumigate right through the orchard, but the inspector goes round and marks those he thinks badly infested, or reasonably supposed to be infected, so that scale is never cleaned right out of the orchards. In fact, things were becoming so unsatisfactory that, while I was in Washington, Mr. Marlatt, of the Federal Department, at the request of the State Board of Horticulture, left for Los Angeles to carry out a series of tests with the State Inspectors, for the best methods of fumigating.

As an instance of the powers of these Boards, "the White Fly scare" is a good example. The White Fly (*Aleurodes citri*) is a very serious pest to the orange growers in Florida, where it has been known for many years. Early last year (1907) it was discovered in a number of gardens at Marysville, and determined as identical with the Floridian pest. There were no orange orchards in the town, and the fly was doing no practical harm in the parks and gardens; but the owners of citrus orchards some distance away raised a cry that their industry was doomed if it was not destroyed. The town stood in an angle of four counties; Mr. Carnes served 320 notices on the municipal authorities and householders, ordering them to cut down, strip, and defoliate all trees and hedge plants growing in their grounds upon which White Fly had ever been found. At their own expense hundreds of householders, through no fault of their own, to no benefit to themselves, were at a moment's notice, compelled to work themselves, or pay someone else to do the work of destroying their private gardens. In a second outbreak at a gentleman's ranch further south, the whole of the available staff of the Horticultural Commissioners, with an army of Japanese labourers, chopped all the trees down; the stumps were fumigated twice; the tops and brush all carted away; the leaves picked up, bagged, fumigated, and then burned.

According to the published reports, White Fly was exterminated in California; but on a visit to Marysville with Professor Woodworth some months after the Commissioners' work was over, we saw living White Fly in several places, and heaps of dead foliage in the streets that had never been burned. The Commissioners have since had two men constantly inspecting the gardens and destroying any larvæ or pupæ that they discover.

With all these powers, and so much money expended in bringing beneficial insects from all quarters of the globe, what have the Commissioners done in cleaning up the commercial orchards? And what would happen if all spraying and mechanical methods came to a standstill? At Marysville, at Sacramento, in the parks, gardens, and streets of southern California, there was just as much red scale, brown scale, and purple scale as in Australia—in fact, with the dust of the dry season and the scale, all the uncultivated, unsprayed trees looked much worse than they do around Sydney. If the parasites (introduced) have done so much good, why is this the case? In all the large packing-sheds I found people washing and cleaning the oranges before they were graded. If they have to be cleaned before packing, it would hardly matter if there was another 10 or 20 per cent. of scale to be washed off. Their native parasites, particularly small chalcids, are common on all scale or blight-infested trees, and, according to some authorities, do more than the introduced species. *Comys fusca* is one of the most active in infesting the Brown Scale (*Lecanium hemisphericum*). The brown scale parasite, *Scutellista cyanea*, which was so useful in South

Africa, though it attacked a large percentage of the olive scale upon the pepper and other shade trees when introduced into California, never became established in the commercial orchards outside the towns.

In the Capitol grounds at Sacramento there is a large patch of citrus trees, which are not disturbed or sprayed; these I found covered with red and yellow scale and also several lecanid scales. While at Sacramento I visited a number of orchards on the American River. The apples are not grown on blight-proof roots as in Australia, but the true Woolly Aphis (*Schizoneura lanigera*, Hausm.) does not seem to affect the trees so badly as it does with us; but here the foliage of the apple trees was so badly infested with a green-leaf aphis (*Aphis mali*, Fab.), that they all looked as if they had been sprayed with dirty oil and it had run down the trunks. Powdery mildew had been very prevalent in all the land along the rivers, and the upper branches of many of the peach trees were quite bare of leaves. Coming nearer to the town, all the pear orchards looked very unhealthy, with dead branches showing out in most of the trees. This was caused by "pear blight," a mysterious bacterial disease that is spreading all through the pear orchards of California, and I was told that there are 2,000 acres of what were once valuable pear-trees in the Sacramento Valley dying out from this disease. In southern Texas I afterwards saw orchards in a very bad way from "pear blight," and in other parts of America this very serious disease is becoming only too common.

This might be very easily introduced into the pear orchards of Australia, as it is very widely spread over the United States. No remedy is yet known except cutting back branch by branch as it dies back; and this, apparently, is only a temporary check. Therefore we should take united action and prohibit all kinds of pearwood, buds, &c., from any country where pear blight is recorded.

At Marysville I saw several very large peach canneries where the labour is all white, and everything is carried along by machinery in a most expeditious manner.

Near by is Yuba City, where there are a number of large grape and prune orchards. I visited Mr. Staples' packing-house; here they were packing and sending away daily from 300 to 400 packages of Thompson's seedless grapes, and expected to keep on packing for nearly six weeks longer. Each package contained 20 lb., valued at 6d. per lb. at that time; but this price was much higher than the usual rate. He also had a gang of men, most of them Chinamen (the best labour in the State for this work, he claimed), curing prunes. At Mr. Onstott's there are 475 acres of raisin grapes, and when his outfit is in full working order, he covers 14 acres with drying-trays. He had an apple orchard of some 35 acres in a very neglected condition, of which he was rather proud, as he said without any spraying or preventatives there were no codling moths in his apples. When I showed him at least a dozen grubs in a few moments, he said it did not matter, as he got enough apples for his house!

At Lodi, another town visited, great quantities of grapes are grown; no irrigation is required, as the subterranean water is within 6 feet of the surface. About 50,000 acres are under cultivation, half of which are used as table grapes and the other half for wine. Though phylloxera is common in California, resistant stocks are comparatively unused; the growers consider that the cuttings are so much cheaper, that by the time the disease has reached the killing stage, they can afford to dig them out. Acting on instructions from the Victorian Government, I stopped at Fresno, on my road to Los Angeles, to see Mr. Geo. Roeding, who is the American authority on

the caprification of Smyrna figs. He took a special trip, some years ago, to Smyrna and the Levant, to see the methods employed in the East; but it was under the supervision of Mr. Swingle, of the United States Department of Agriculture, that the successful introduction of *Blastophaga grossorum* (the tiny fig insect) was accomplished. Mr. Roeding, who has a large nursery and fruit-drying outfit, has all the different Capri figs growing in the orchard with the Smyrna figs, and has demonstrated that Smyrna figs can be produced in this part of California as perfect as those in the Levant.

The Capri figs are numbered 1, 2, 3, 4, of which No. 1 is the best, as it bears figs nearly all the year round. The fruit of the Capri figs, containing the tiny wasps, are plucked off the trees and tied in strings or hung up in little wire baskets on the branches of the Smyrna fig-trees. It is said that one insect will fertilise a fig. The crop of Capri figs must be continuous, so that the varieties growing the most irregular crops, like No. 1, are the most useful. The fig industry, however, is not a very important one in California; with all the influence Mr. Roeding has had, only a few people have embarked in the industry. This gentleman also grows large quantities of muscatels and Thompson's seedless grapes, which are turned into raisins. Before the Pure Food Act came into force in the United States last year, sulphur was used in the treatment of the grapes and prunes; now most of them are sun-dried. Several of the growers wanted to know if our raisin-growers were allowed to use sulphur for drying, and claimed that it was a great hardship, for the raisins never had the same colour when simply sun-dried. Dr. Wiley, of Washington, who was responsible for getting this great Act against adulteration passed, told me "that if a man wants to take sulphur into his system, he should know when and how he is taking it." Since then, the authorities at Washington have agreed to let the growers use sulphur for two years longer, until the matter is further investigated. Sunnyside, an adjoining estate, contains 640 acres of grape vines, and there are several large wineries in the vicinity of Fresno.

From Fresno I went on to Los Angeles, where I placed myself in the hands of Mr. Jeffery, Horticultural Commissioner of the district, who has since been elected Chief Horticultural Commissioner for California. He has a large staff of inspectors, as this is an important centre of the orange industry. In the San Gabriel Valley there are 8,000 acres of citrus orchard, all under irrigation, and, in the older orchards, the trees were covered with fruit in fine condition; but there was plenty of red, yellow, purple, and black scale on some of them, and they were going to start fumigation in about two weeks' time (23rd September). I spent one day motoring through this valley with Messrs. Jeffery and Bemish, and visited the Govina Low Lands Packing Company's establishment, a co-operative society comprising some forty members. Here all the boxes are made by machinery, the fruit washed, graded, and packed, and they can turn out 500 car loads a day.

Here I was told that if permanganate of potash is mixed with the water through which the oranges are passed, to be washed and rubbed before grading, there is no danger of black spot appearing upon the skin. It may be quite correct that in an incipient state this disease is thus checked, and is, therefore, worth noting.

At Los Angeles I met the manager of the California Fruit Exchange. This is organised in the following manner:—Each district of from 20 to 150 growers combine, and make an assessment on their orchards, the funds of which are used to build a co-operative packing-house. They then elect one of their members to a County Board, which consists of nine mem-

bers, each representing a group. This board levies 5 cents a case upon the fruit under their control, and one of the number is elected as manager, and has an office in Los Angeles. His duties are to keep in touch with all the eastern markets; to send off the fruit to the best advantage; conduct all sales and office business; and his expenses are paid out of the 5 cents levy per case.

Coming back to San Francisco, I stopped half a day at Santa Barbara, and went through the walnut orchards.

On my return from southern California I went up to Santa Rosa, and saw the hop-fields, and called at Mr. Luther Burbank's nursery; he declined to receive anyone, but furnished me with a lot of literature on his work.

I visited the two large Universities, where a considerable amount of entomological work is carried out. The University of California is at Berkeley, across the bay from San Francisco, and has a large section of agriculture under the direction of Professor Wickson, with Professor Woodworth in charge of the Entomological Branch, who, while attending to economic research work, gives a regular course of lectures to students.

The Leland Stanford, junior, University is at Palo Alto, about 68 miles south of San Francisco, and is a modern institution endowed by Mrs. Stanford. A great many of the buildings suffered severely from the effects of the earthquake, when San Francisco was wrecked, but this was being rapidly repaired at the time of my visit. This University is under the direction of Dr. Starr Jordan, and Mr. Vernon Kellog, a well-known writer and entomologist, is in charge of the entomological work.

I also met Professor Koebele at his home in Alameda, and went through his large collection of economic specimens from all parts of the world, and obtained specimens of several fruit-flies and the parasite he had bred from the Mexican Fruit Fly. As he intended to go down to Mexico later on in the season, to search for parasites for the Hawaiian Sugar Planters' Association, we arranged to meet at Mexico City, after I had been to Washington, and as he had been down in that country on four or five expeditions, it was of great advantage to me to join forces with him in a strange country.

I left San Francisco on the 17th September, and arrived in Washington on the morning of the 22nd, when I went to the Department of Agriculture, and presented my credentials to Dr. L. O. Howard, Chief of the Bureau of Entomology. He at once took me round and introduced me to all his officers, and, acting on his advice, I visited each officer in turn, and saw the different methods adopted for arranging, mounting, and storing the specimens, &c. The first Bureau of Entomology was formed in 1854, under Townsend Glover. In 1894 it carried an appropriation of 30,000 dollars, and consisted of the chief, with eight scientifically-trained assistants, and three clerks and messengers.

Speaking before the members of the Seventh International Zoological Congress at Boston last year (1907), Dr. Howard said: "At the present time of writing, the entomological service has been given bureau rank; its budget for the present year is 340,000 dollars, and its pay-roll includes 100 scientific assistants and 250 other employees." In the Botanical Bureau, which is split up into a number of divisions, there are about seventy trained botanists, without counting a small army of collectors, &c. In the Department of Agriculture there are over 10,000 officers. This is the Federal Department. Outside this, under the Adams Act, there are sixty State Experimental Stations or Agricultural Colleges, one to each State; and in seven others special stations are maintained, such as the Pest Crop Commission of Louisiana, at Baton Rouge, &c.

Many of the State Agricultural Experiment Stations have well-known entomologists on their staff. Last year, including Hawaii and Porto Rico, there were fifty-one stations with entomological workers; so that the list of official entomologists in the United States is a long one, and contains names of men who have made a world-wide reputation.

At Washington, each officer works at a certain group or division, as Dr. A. D. Hopkins, who is in charge of Forest Insect Investigations, and Professor F. M. Webster, in charge of Cereal and Forage Plant Insect Investigations. Others rank as assistant entomologists, and often deal with a single order of insects, such as D. W. Coquillet, who takes the flies (*Diptera*), and Dr. Swartz the beetles (*Coleoptera*). These specialists, again, have their assistants; while there are always a number of men on the staff who are known as special field agents.

Under the Department of Agriculture there are ten well-defined Scientific Bureaux and Divisions, some of which are again split into smaller subdivisions; but the ten gentlemen in charge are responsible for the working of their respective branches, and deal directly with Mr. Wilson, the Secretary of Agriculture. There is no Director of Agriculture, and the system apparently works very well.

One of the weak points in the smaller subdivisions is that the ambitious man, when he becomes head of a subdivision, tries to get all the subjects allied to his particular subject into his hands at the expense of the next man; and as the sub-divisions increase this will become more acute, and the work may overlap.

I spent a fortnight, under Dr. Howard's advice, first visiting all the different officers of the Entomological Staff, some of whom work in the National Museum, while others are scattered about in offices and buildings rented by the Department until their new building is completed, and afterwards the heads of the other bureaux. With Mr. C. L. Marlatt I went through the collection of *Coccidæ* (scale insects), which is by far the largest collection in the world of these important pests. Still, until the last few years there was hardly a collection of any kind of these insects in any of the scientific museums. Here all the micro-slides of coccids are kept in paper envelopes, and arranged in cabinets like small card catalogues. Coccids are very unsatisfactory insects to arrange in reference collections, and every worker at these scale insects has some special method of preserving them. In Hawaii they were all kept in glass tubes plugged with cotton wool; in Washington they are placed in shallow cardboard boxes, that fit close together in insect cabinet drawers, the name of each written across the outside, and all particulars written and placed inside with the specimen. All the specimens in the National Museum collection, which are in charge of Dr. Howard, and those in the working collections in the offices, have a stock-book number, a system which was started when the collections were first formed. I examined all the mealy bugs or soft-bodied coccids with Mr. Sanders, who is in charge of one section of the *Coccidæ*, and is inspector of plants introduced into the United States. Under the care of Mr. Oliver I went through the propagating grounds, where there are many wonderful plant experiments being carried out in a series of large glass-houses upon hybridization, development of strong-rooted grasses, layering and grafting of mangoes and other tropical fruits.

Some time was spent with Mr. Nathan Banks, the authority on lace-winged flies (*Neuroptera*), and also in charge of ticks and mites, to whom I submitted specimens of doubtful Queensland cattle ticks given me for expert determination by the Chief of our Stock Branch in Sydney.

At the National Museum I examined many drawers full of parasitic hymenoptera with Mr. Ashmead, who is one of the leading authorities upon these most interesting little creatures, of so much economic importance in the destruction of pests, and then went through some groups of the *Coleoptera* with Dr. Swartz. Here, also, is a very fine collection of *Psyllidæ*, or "Leaf Fleas," small homopterous insects that are very abundant in Australia, where, on the native bush, they appear to take the place of aphids or plant lice.

With Mr. Coquillet I left some specimens of a fruit-fly, which he has since determined as an undescribed species of *Dacus*. With Dr. Harrison Dyer the curious slug-moths and their larvæ were examined. These are allied to the cup moths of Australia, some of which often defoliate our forest trees. Dr. Hopkins gave me a very interesting morning, going through his work on those insects that play such an important part in the destruction of forest trees. He has been working twelve years on one group of beetles—the *Scolytidæ*—which do so much damage to the pine trees; and he has had maps prepared showing the range of each species. He has made a study of the life history of each species in detail, which has made his advice of such value to the Forestry Department.

Some time was spent with Professor Webster, in charge of field crops and their diseases. He is a well-known authority on the Hessian Fly and the Chinch Bug, both very serious wheat-pests in the United States, but not yet known in Australia. One pest that might be very easily introduced into this country is a seed-destroying chalcid wasp (*Bruchophagus funebus*, How.). It lives in the larval state in the seeds of red clover and lucerne, and has been carried in these seeds into several parts of the world where it was previously unknown.

With Mr. Quantance I went into the question of fruit-pests and their range in North America, and their methods of using sprays and spraying outfits. Little or no fumigation is done in the Eastern States, probably because the most serious scales that chiefly attack citrus trees in the west are unknown in the New England orchards. Compressed air is used in spraying; and in some sprayers, used chiefly in the vineyards, the action is geared on the wheels and the nozzles adjusted on either side.

The cherry and apple fruit-flies, long known as *Trypeta pomonella* and *T cerasi*, are only minor pests, the latter rare; still the apple fruit-fly sometimes becomes a very serious pest in isolated places. Later on, at the grounds round Cornell University, we found the apples very badly infested with a grub, which Professor Slingerland said was this fly. One of their worst fruit-pests is the Plum Curculio (*Conotrachelus nenuphar*, Horbst.), which damages not only plums but apples, pears, cherry, and peaches. The beetle lays its eggs in the young fruit early in the season, and the adult larvæ, after burying themselves in the ground, emerge later on and feed on the ripening fruit. Codling moth and woolly aphis are common in all the apple orchards, but in some of the Northern States, like New Hampshire, and parts of New York State, commercial orchards are very few; and all through the former State most of the apples were grown along the fences or in very small lots. Georgia is one of the most important fruit-growing States, where a great quantity of peaches and apples is grown. The insectarium at the time I was in Washington had a somewhat neglected look, as it was at the end of the season. There was nothing remarkable about their methods or the way in which they looked after and bred their insects. The Entomological Bureau at Washington has so many field agents in touch with the breeding cages of the Experiment Stations that the central insectarium does not appear to be so important as it was at one time.

The Silk Division of the Bureau is under the management of Mr. Gilles The seed (eggs) are purchased by the Division from Italy, France, or Japan, and distributed free to the cultivators. Young mulberry trees are supplied in the same manner, and people are given full instructions how to feed and look after both the worms and their food supply. When the cocoons are ready the Dapartment buy them from the grower, giving him a bonus of 1 dollar 15 cents per lb., a fraction over the usual market rates.

The cocoons are received in the silk-house, and there the enclosed pupæ are killed by placing them in closed boxes with bisulphide of carbon; they are afterwards dried for about three weeks in the sun in shallow wire-bottomed trays, but if placed in a fruit-evaporator the process of drying only takes two days. These cocoons are reeled in the departmental laboratory on a Berthold spinning machine by expert girls, who were taught the methods of working the machine, and also of dealing with the silk, by two French experts, who were specially engaged for this work. The silk is made up into large hanks, and sold to the manufacturers by tender. There is a very heavy import duty upon silk goods and dress pieces coming into the United States, but raw silk comes in free. There are over a hundred silk factories in the United States under this protection.

Pebrine is a rare disease here, but *Flacherie*, caused by improper feeding, is very common, and the smell of decaying silkworms has frequently brought the operations of a prospective producer to a close. The eggs can be kept in cool storage at a temperature of 40 degrees for about eight months, after which they are useless. To hatch them out the temperature is brought up to 75 degrees for a week. It is found advisable to kill all the grubs that hatch out on the first day (known as "gallopers"), and save all from the second to the thirty-fourth day, destroying all those coming out after that date.

With the high rate of labour in the United States, it will be a very long time, from all accounts, before the silk industry will be self-supporting and of any great national value.

Dr. Phillips has charge of the Apicultural Division, which is a very important branch, for there are half a million bee-keepers in the United States in the east. Most of the "bee ranches" do not possess more than 100 hives, but in California there are some ranchers who own as many as 1,000 hives. In the laboratory the question of bee paralysis has been studied, and Dr. Phillips is of opinion that quite a number of diseases are placed under this general name. There are two forms of foul brood, according to Dr. White, who has discovered the second, *Baccillus ulvæ*, the common one in America. He would be very glad to get specimens of foul brood from Australia to study. Here, also, are analysed hundreds of samples of honey. Records are kept of all the bee-keepers to whom pamphlets are sent, and they try to get in touch with every bee-keeper in the States.

The most interesting experiment to the outsider is probably the activity of a hive. A special Fairbanks' weighing machine, adjusted to weigh from $\frac{1}{4}$ of an oz. to 400 lb., is used. A hive of bees is placed upon the scales, and accurate observations and records are made of the changes that go on, with the weight of food given, increase in bees, quantity of honey, &c., and many interesting facts have been revealed in this manner.

In the Bureau of Plant Industry I met the chief, Mr. B. T. Galloway, and many of his officers, who have travelled all over the world to find new or improved species of plants of commercial value, and have done wonderful work in transporting and acclimatising new fibre plants, fruits, and fodder plants; such names as D. C. Fairchild and W. T. Swingle are known wherever such work has been carried out. With the latter gentleman I went through the

[*Photo. by Prof. W. D. Hunter.*

Ginning Mill showing Bales of Compressed Cotton, Calvert, Texas, U.S.A.

great collection of cacti that had been gathered from the deserts, and housed in the Department's hot-house. He pointed out what a wonderful example of evolution was seen in the different kinds of spiny growths produced by the cactus plants, to protect themselves from their many enemies in a desert where they are the only edible thing for the wandering animals. He rather discredits a spineless cactus, such as the Californians claim has been produced by Luther Burbank, for, he says, without its spines a cactus could not exist. He was greatly interested in the flora of the interior of Australia and in my account of our drought-resisting forage scrub trees, and the way in which the introduced cacti had spread over the land, for in Mexico and America they never seem to get away from their home in the poor desert lands where nothing else will grow. He is carrying out some experiments in planting date-palms in Colorado, and thinks that we should be able to grow dates at a profit round the irrigation bores in the interior.

Mr. Dewey showed me samples of the many fibre plants that have been experimented with in the United States, and said from their experience with the Bombay aloe (*Argave cantula*), it might be grown at a profit in Australia. He said that the true Yucatan-sisal, or hemp plant, had never reached either Honolulu or Queensland.

Mr. Collins, who has charge of the cotton section, informed me that sixty millions of dollars worth of cotton is grown in the United States, of which only three to four millions is exported, and about ten millions' worth of Egyptian cotton is imported in its place; but I propose to deal with the Cotton States later on.

Maize (corn) is another plant which forms an immense food staple all over the States, and the plant breeders are always at work improving the old or creating new varieties. Some are to grow rapidly in dry climates. They are breeding forms found in Mexico, with very little foliage and small cobs, but which will produce a crop in three months; others from South America, on the other hand, take nearly a year to mature a crop. The quantity of maize grown in the Central States is something enormous; after coming through the western plains there are hundreds of miles of maize fields right up to Chicago.

The germination of seeds is carried out in this Plant Industry Division. The seeds being tested are first counted, and sent to the officer in charge of the laboratory, where various methods are used with different seeds. There were thousands of little grass seeds on the surface of damp blotting-paper, others under saturated cloths, or between sheets of thick blotting-paper. These are placed in ovens of varying temperatures, and every packet checked and tabulated. Then they have a staff of ladies, who examine all samples of seeds sent in by people who have purchased them, and want to know if they are up to standard. Each sample is microscopically examined, the seed true to name placed in one packet, the foreign seeds, if any, in a second packet, and the inert matter, dirt, &c., in a third package. To verify their determination they have a reference collection of all the commercial seeds, seeds of weeds, &c., in small tubes.

In another branch all drugs and the products of plants are examined, and particularly those plants reputed to be poisonous to stock and man.

The Bureau of Animal Industry takes up the duties of our Stock Branch, and also covers a number of other branches. Dr. Mueller took me round the laboratories and showed me the methods of preparing preparations for injection for blackleg, malleen for glanders, and tuberculin for cattle. Great quantities of these are made up and sent to the stock-owners.

The officers of this bureau told me that sheep scab is still common in the United States; anthrax occurs every now and then, and on several occasions has been traced to hides in tanneries; foot and mouth disease has been stamped out; but hog plague is very common, and has been closely studied. Though caused by a minute bacillus, it is essentially a dirt disease in the first instance. This bureau analyses and publishes a list of the proprietary substances permitted in official dipping of sheep and cattle for scabies. In the list printed in August, 1907, there are forty-two different washes, consisting of lime and sulphur, coal tar extracts, and tobacco extracts.

The Bureau of Biological Survey is another branch closely related to the Entomological, as it deals with the range and distribution of birds and animals; the value either from the point of game or food; and their value as insectivorous birds. In the absence of the Chief, Dr. Fisher took me round. The collection and examination of the stomachs of many thousands of birds have been carried out, and thus the food of each is known, and the insectivorous ones are protected. This branch has issued many valuable reports on the value to the farmer of different groups of birds. In the work on noxious animals, maps have been made, showing the districts infested. The sage rats, or ground squirrels as they should be correctly called, are almost as destructive as our rabbits; in one district in the north-west last year they destroyed 300,000 dollars' worth of wheat. The chief poisons used to destroy these pests is strychnine and phosphorus, bnt they are very cunning and not easily poisoned. It is reported that a tubercular disease spontaneously sprang up among them last year, causing a great mortality in some districts. The officers of the department are trying to obtain and propagate this disease. The branch deals, to a large extent, with the Game Laws and Bird Protection Acts, and it would probably be a very good idea for the Australian Departments of Agriculture and the officers of the Forestry Departments to have charge of the Bird Protection Acts, which at present only exist and are administered by no one in particular.

The Forest Service is under Mr. Gifford Pinchot, who has done so much in protecting the remains of the American forests. On paper the United States national forests cover an immense area, but in reality the eyes have been cut out of them; and, according to authentic reports, millions of feet of the best timber have been stolen by some of the lumber companies, and thousands more destroyed by forest fires. It is only a matter of a few years hence when the people of the United States will have to go to Canada for their lumber.

In 1891 Congress authorised the President to establish forest reserves, now known as national forests, and the Yellowstone Park was proclaimed as such the same year. At the present time there are 145,000,000 acres of national forest, without including another 5,000,000 in Alaska and Porto Rico.

These are chiefly composed of coniferous trees, and are all situated in the north and north-west; there are no forest lands belonging to the Government in the Eastern States. There is very little replanting going on. The supervisors have direct charge of the forest lands, and all business passes through their hands. Under them come the rangers, who live in central points in the forest, and carry out the work on the ground—sell timber, grant permits for settlers or miners to cut timber, fight forest fires, and patrol the country. Included in these forest areas are some agricultural lands, which are let as homestead leases in blocks of from 160 to 320 acres. There is also much of the forest which adjoins the "free range country," where sheep and cattle men graze their stock on the Government lands, and

[*Photo. by Prof. W. D. Hunter*

Field Experimental Cage in the Cotton Fields at Dallas Texas, U.S.A.
Used in the Boll Weevil Experiments.

pay no rent. This system of "free range," which has led to so many acts of violence in the States in which it is in vogue, is also responsible for a great deal of damage to the young forest trees in consequence of the stock trespassing.

The importance of the Weather Bureau to the Department of Agriculture can be understood by the value of the "frost" warnings issued to let the farmers know when hard frosts are to be expected. Two weather charts are issued every day, so that any cyclonic disturbance can be located and watched from one end of the States to the other.

Acting still on Dr. Howard's advice, I arranged to visit Cornell University as being a typical example of an up-to-date agricultural college. Leaving Washington in the evening, I reached Ithaca early next morning and took the tram to the hills beyond, on which the University stands. The chiefs of the station staff, L. H. Bailey, the Director, and Professor J. H. Comstock, are two of the best known names in the Universities of the United States. Professor Comstock had just removed with his staff to the new agricultural buildings, that overlook a wonderful range of country and are fitted up with all the latest improvements for teaching; he went with me over the magnificent library and through the lecture rooms, insectarium, and museum collections. Here I met the members of his staff, Messrs. Slingerland, McGillvray, Bradley, and Needham; and at a meeting of the Entomological Club, at the Professor's request, I gave the students an address on economic entomology in Australia.

Dr. J. G. Needham has an interesting experimental house on 5 acres of marsh land on the great lake below the college, where he has a boat and apparatus to study the growth and transformations of all kinds of water insects, &c., the chief food supplies of freshwater fishes, and the methods of dealing with mosquitoes and other marsh-land pests. The marsh land was handed over on a perpetual lease to the University by the owner, an ex-student, for this special work.

On the following evening I left for Boston to meet the officers of the Gypsy Moth Commission, who have charge of the work of destroying this foliage-eating moth in the State of Massachusetts.

The first Commission was appointed in 1890, with an appropriation of 50,000 dollars; in the following year a second Commission was appointed, which was soon after taken over by the State Board of Agriculture, and another 50,000 dollars was obtained; and in 1892 the State Legislature passed 75,000 dollars to continue the work. In 1893 the Commission asked for a further sum of 165,000 dollars, and were finally granted 100,000 dollars; and the total sum that had been spent by the State at the end of 1895 was over 450,000 dollars, and still the Gypsy Moth was flourishing.

A regular staff was always working, and many reports were published, until, in 1906, the Federal Department of Agriculture was asked to take it in hand, and Dr. Howard visited Europe to inquire into the conditions of the Gypsy Moth in its native home, for it was originally introduced from France. He made arrangements with many of the European entomologists to send over packages of the winter caterpillars of the moths, which are being cultivated in the Federal Insectarium, near Boston, to see if they can obtain from them parasites that are known to exist in Europe, in sufficient numbers to check its spread.

There are, therefore, two distinct Commissions at Boston—the State Commissioners and the officers of the United States Experiment Station. The State Commissioners are under Mr. Worthly, with whom and some officers of

the Federal Branch I travelled over about 200 miles of the infested country; it is open forest country, but round Beverley are the grounds and homes of the wealthy people of New York and Boston. The infested area contains 8,000 miles of roads, along which much of the work of burning and clearing out the egg masses and grubs has been carried out. As many as 1,700 men have been employed at one time, and at the time I was there the Commissioner estimated there were about 1,000 at work. There are five special field agents and commissioners, who meet at the Control Office every week; and the entomologist in charge, Mr. Kirkland, has a salary of 5,000 dollars a year. The money to carry out this work is found by the State Legislature voting a certain sum, and then there is a regular assessment on every town in the infested districts. If any town has to spend more than its regular assessment, they can obtain a refund up to a certain limit from this State vote. The Federal Experiment Station is under the charge of Mr. Rogers, with a special vote of 10,000 dollars to be used under Dr. Howard's advice in introducing and experimenting with all kinds of parasites, some of which have been turned out in thousands. At present it is too soon to notice any effect, but as this is one of the biggest experiments of the kind that has ever been undertaken, the eyes of all the economic entomologists of the world are on the Gypsy moth and its parasites under the skilled management of Dr. L. O. Howard, who does not claim that they will be successful, but as he has the money and opportunity he is going to try, for up to date all mechanical means have failed. After a flying visit to the Natural History Museum at New York, on my road back to Washington, I returned on 12th October. On 15th October I left Washington for New Orleans, with Dr. Howard, to see the pests of the Southern States and study the Cotton Boll Weevil in Texas. We arrived at New Orleans about midnight on the next day; and there we met Professor Hunter, who is in charge of the Boll Weevil Experiment Station at Dallas, Texas.

The main crop all through these Southern States is cotton, in which everybody is interested; in consequence of a strike of the wharf labourers, there were thousands of bales of cotton piled up on the wharves waiting for transport. Cotton is grown at so close a margin of profit in the Southern States that every pest that attacks the crop threatens the whole output. Nothing is more dreaded than the cotton boll weevil, which has caused so much destruction in Texas, has crossed the Mississippi, and is now common at Baton Rouge, under 100 miles from New Orleans. This little weevil (*Anthonomus grandis*) lays its eggs in the immature boll of the cotton bush, and the young larva feeding within causes the boll to turn yellow and drop off. As soon as one reaches an infested district where they are abundant, it will at once be noticed that all the lower part of the plant is bare of bolls, while all the good bolls are on the upper portion; in many districts half the crop is destroyed by this beetle. Under the present conditions of cultivation it seems a very difficult matter to deal with such a pest; for those hibernating among the dead plants and rubbish left on the ground after the crop is gathered, appear next season ready to carry on the work of infestation. Some of the preventatives that have been carefully considered are—first, the growth of a cotton that will mature rapidly before the weevils get to work; another, some cheap method of utilising the dead stalks of the cotton plants, such as making them into paper; and experiments are being carried out along these lines.

A large number of different kinds of parasites and predaceous insects have been found destroying the boll weevil at different stages of its growth, but none have made any impression. Among one of the most remarkable means of

[*Photo.* by *Prof. W. D. Hunter.*

Cage for the Study of Boll Weevil and other pests. Dallas Experiment Station, Texas, U.S.A.

exterminating this pest was the one proposed by Mr. O. T. Cook, of the United States Department of Agriculture, who introduced an ant that he found in Guatemala, which he stated devoured the local boll weevil, but though 4,000 were brought over, there is no record of them ever having fulfilled their mission; and the people, reasonably afraid of a new pest in the ant, made objections, which stopped further consignments being sent.

At the Dallas Experiment Station there is a trained staff of entomologists, and thousands of living boll weevils are under observation in the breeding cages, and some very fine reports have been issued on the work.

We stopped at Baton Rouge, where there is the Louisiana State University and Agricultural College, and a second branch, called the Pests Crop Commission of Louisiana. The latter is under the care of Mr. Newell, who is well known on account of his experimental work with cattle ticks; he also deals with all kinds of pests and diseases of crops, gardens, and orchards His laboratories are very well fitted with all the latest improvements and appliances. From the study of the life history of the larval ticks, it has been found out how long they can exist without food after hatching from the eggs. He contends that if all stock is kept out of a paddock over that time, the tick infestation dies out, and that by gradually extending this clean area, a whole district can, with these precautions, eventually be freed from ticks. He rather discountenances any smearing or dipping of cattle and stock to kill the ticks upon them, because if this was universal they would not carry out his methods. With a combination of both methods I think he would have much more chance of success, for a straying beast getting into a clean area would destroy the whole year's work. He had a number of different animals housed round the station artificially infested with different species of ticks. He says: "The investigations which various entomologists have made of the life history of the cattle tick, show that its complete and total annihilation in the United States is not only a possibility but an assured fact, when the farmers and cattlemen understand that this can be accomplished, and when they set to work in steady co-operation with each other and the proper State officials, to remove the cursed parasite from the South."

Here we made some observations on the increase of a small black ant (*Iridomyrmex humilis*), introduced, it is believed, from Buenos Ayres, with specimens exhibited at the St. Louis Exhibition. It bids fair to be a very serious house pest, and is swarming all over the town. Considering that we had suggestions made to some of our landholders a few years ago to introduce an African ant to kill out the rabbits, it is interesting to note this fact to show how easily an ant may become a plague.

From Baton Rouge we went on to Shrieveport, where Dr. Howard has some officers at work on boll weevil experiments, and going on from here we came into the well-defined weevil-infested country, after crossing the Mississippi. From Shrieveport we went on to Dallas, and now were in Texas, and on some poor country saw some fields of what is locally called "Bumble bee cotton," that is, cotton plants that are so stunted that a bumble bee resting on his hind legs can suck the honey out of the flowers. The Texas State Fair was being held at Dallas, and on the Sunday I went through the stock exhibits with Professor Hunter. Everything was just as busy as on a week-day. Cattle were well represented, and the typical "red hog" was the favourite breed of pig, though there were a few exhibits of Berkshires. There was only one small lot of sheep, as sheep are not run on this part of Texas.

From Dallas we travelled down to Houston, through some of the richest cotton land of the State; over a million pounds' worth of cotton came from a rich belt known as the Ellis district. Stepping out at mid-day at College Station, we went to the State Agricultural College, where, while Dr. Howard was on his business bent, I went round with the Director, Mr. J. W. Carson, through the laboratories, over the cotton mill, and the small cotton factory. In the laundry we found several gangs of students doing all the washing and laundry work of the College. There are 800 acres of land on the farm, and about 600 students come from all parts of Texas and the adjoining States. There are so many that a large number are camped in tents in the park.

We went from Houston to Galveston, where we spent some time at the Medical School. Some very extensive experiments have been carried out in dealing with yellow fever and the mosquitoes. This town was almost swept out of existence on the night of the 8th September, 1900, when a tornado swept the ocean right over it, and 79,000 of the inhabitants were drowned. Since then the remaining citizens have built an immense sea-wall, from 10 to 14 feet high, right round the city, and pumped in 10 feet of sand, so that the whole town has been raised, and rebuilt to this height above the sea-level.

On the low flat land between Houston and Galveston there is a considerable amount of rice grown, chiefly of the Japanese and Honduras varieties. There are some extensive fig orchards, and large areas of vegetable gardens; while at Webster nothing but strawberries are grown. There were a number of pear orchards on the road, but all of them were badly affected with pear blight; every tree was full of dead branches. Most of the country in this region is in the hands of Italian or Japanese settlers. One of the results of an Italian settlement in a district is, I am told, that every bird, big and little, is shot and eaten, as in their native country. Returning to Houston we left in the evening for Victoria, and after passing through a large sugar plantation, soon came on to the open prairies. On the train we met the manager of the Pierce Ranch, who wished to show Dr. Howard his imported Indian cattle for report to the Minister for Agriculture, so we dropped out at a wayside station in the dark, and spent the night at the homestead, getting up at daylight, and travelling about 25 miles in a motor before breakfast.

These large Indian cattle came from the Montgomery district in northern India, which is famous for its cattle, and Mr. Bindon made a special trip on behalf of some Texan stockmen to India, where he purchased and shipped them over to the States at considerable expense. The breeders claim that not only does a cross with a Texan cow produce a large and much quieter beast, but that the skin is covered with such a very fine short hair (unlike the local Texan cattle) that they are immune from the attacks of cattle tick. This was accounted for by a theory that the beast's coat was so short that the larval ticks, if they succeeded in getting on to the animal, always dropped off when they underwent their next moult, for there was nothing for them to cling to when undergoing their transformation. Later on in Jamaica, where a similar Indian strain was introduced many years ago, and a very great number of the beasts in the "cattle pen" country showed striking Indian characteristics, I was told by one of the oldest stock breeders that he considered they had spoilt their cattle by the Indian blood, for the flesh was not so good, being much coarser. Large quantities of rice, cotton, and lucerne are grown on this estate; some of it with State prisoners, who are let out to the ranch-owners in gangs, in charge of a warder, who is responsible for them, the rancher paying so much a month per head for his State convict labour.

[*Photo. by Prof. W. D. Hunter.*

The Laboratory, Dallas Experiment Station, Texas, U. S. A.

From there we went on to Victoria, where there is a small experiment station under Mr. Mitchell, who has been located there for fifty years, and is an authority on the natural history of Texas.

At San Antonio I made arrangements for going on to Mexico *viâ* Laredo having telegraphed to Professor Koebele, who had left Alameda the week before and gone down *viâ* El Paso. Here I parted with Dr. Howard, who was returning next day *viâ* Chicago, and with Professor Hunter, who went back to Dallas.

I left San Antonio at 10 a.m. and crossed into Mexico in the evening at Laredo. All the country after leaving San Antonio was poor level land covered with low Mesquite bushes, and after crossing the Rio Grande River, on the border, the country became worse. On Sunday morning we were traversing the true Mexican desert, with its miles of sand, cacti of a dozen different kinds, scattered scrubs and low hills, with small mud villages and flocks of goats. San Luis Potosi, the only town of any size, was passed in the afternoon.

Early on the following morning I arrived at Mexico City, where Professor Koebele met me at the railway station, and I took up quarters in the Itiburdie Hotel. I presented my credentials to the Secretary of the Department de Fomento, who informed me that Professor Herrera was away sick, but sent me on to Dr. Giandra, his assistant, who made most of the arrangements for me while in the city. We went through the departmental collections, which are not extensive but very interesting. The Mexican Fruit Fly (*Trypeta ludens*) is the most important pest, from a commercial point of view, as it has caused so many difficulties with the export of oranges into the United States. I, however, propose to deal with this pest in the Appendix (Fruit Flies). The other pests of the orange are the well-known scale insect *Chionaspis citri*, and three species of longicorn beetles—*Instenaspis verticulis, Insdendrobium maxillosus, Insmalacopterus lineolatus.*

Professor A. L. Herrera is chief of the Commission of Parasitologia, which takes the place of the Entomological Branch here, and he has charge of the work of dealing with insect pests, and has a Federal Commission at Yutapec, Morelos County, with a vote of money to administer the Act dealing with the destruction of fruit-flies. Their methods are similar to those we enforce, the cleaning up of the orchards and the destruction, by burning and burying, of all infested fruit; and they claim that there has been a very marked diminution in the amount of infested fruit since they enforced these measures. They have destroyed all the old fences round the orchards, and replaced them with wire and posts; and a number of people have been fined for not cleaning up their orchards.

Most of the oranges over the local supply are shipped in crates to the eastern portion of the United States. These oranges are examined and passed by the State inspector, who gets a certificate from the mayor of the district, under which they are exported.

From the Inspector's report (for September, 1907), there are 9,502 orange trees in Morelos district from which 785,738 oranges were exported, and 19,534 were destroyed on account of infestation of fruit-fly. Many of the larger growers, seeing the value of clean orchards, have cleaned theirs at their own expense. A great number of experiments have been carried out in the laboratory on the action of chemicals upon the maggots; and the inspectors in some places where wood is scarce are allowed to inject benzine into infested oranges to kill the maggots instead of burning them. Experiments have also been made in spraying the trees with a decoction of the foliage of an *Apocynaceous* plant (*Haplophyton cimicidum*), commonly known as the

"Cockroach Plant," which is sweetened and sprayed on the infested trees. The fruit-flies are attracted to it, and die very quickly from its poisonous effects. The formula is 2 lb. of chopped-up plant boiled in 3 gallons of water, strained, and mixed with 3 lb. of sugar. The only parasite that has been noticed is a small Braconid wasp (*Cratosipila rudibunda*), but though at times as many as 10 to 15 per cent. of the maggots are parasitized, it does not seem to be much of a check on the maggots in the orange, but more common in the smaller fruits.

Accompanied by Professor Koebele, Dr. Giandra, and an interpreter, I went down to the town of Yutapec, and spent several days among the orchards, going round with the inspectors, and seeing the examination, packing, and transportation of the sound oranges and the destruction of the damaged ones in the orchards. The district is semi-tropical, with rich black soil and plenty of surface water for irrigation by gravitation. There is no system in planting, and the trees are all shapes and sizes, and all are seedlings. Nothing is known about budding, grafting, or even pruning, yet they grow some very fine oranges. Most of the orchards are small, ranging from 50 to 500 trees, and few of the owners have any very exact idea of the number of acres in their holdings. Labour is very cheap, and the Chief Inspector's salary is only 75 cents per day (1s. 6d.), and the assistants 50 cents (1s.), for twelve hours' work. The oranges are examined by the inspectors as they are being placed in the large open crates that hold 318 oranges. These oranges are sold in the orchard at 25 cents per hundred.

There are several other districts where fruit-fly is known to exist, but as there is no export from them the departmental officers are not dealing with their orchards, their object being more to keep the United States open to their fruit than from any hope of clearing out the fruit-flies.

With Professor Koebele's knowledge of the district around Mexico City, I saw many of the small and much-neglected local orchards. The markets were also visited several times and many different fruits examined. About six different varieties of bananas were on the stalls, a thick red-coloured one being the best flavoured; many different kinds of tomatoes; chillies, and a coarse-looking Cape gooseberry was abundant; three kinds of prickly-pear fruits; and the leaves of another opuntia, from which the spines were cut with a sharp knife and sold for food; the apples and oranges were of very poor quality. A great quantity of different kinds of squashes were there, but no watermelons; one kind of pumpkin is perforated with small holes and boiled in sugar. Many stalls dealt in sugar-cane for eating; the cane is brought into the market on muleback and the market-women chop it up into short lengths. This cane is only grown for eating and is called the Cana de Castilla, the crushing cane for sugar as known being Purple Cane (*Cana morada*).

The vegetables were very plentiful; a great variety of yams, and also, Irish potatoes, in contradistinction to sweet potatoes; these are seldom grown to maturity, and are sold in little wooden platters containing about half a dozen in each platter.

Probably the most curious of the many curious foods on sale in this market were the bags of water-bug eggs, about the size of dust shot. They are obtained in the canals round the city by sinking sheets of matting under water, upon which the eggs are laid in millions. The matting is then shaken over a sheet and all the eggs gathered. These are dried and placed in sacks and sold at so much a pound; they are known as "ahuahutl," and are made into cakes and eaten.

[*Photo. by C. B. Waite, Mexico.*

Drawing off the Juice of the flower-stem of the *Agave americana*, which is collected and fermented to make Pulque, the national drink in Mexico.

There are also large quantities of two species of water-bugs sold in the same manner in the markets. They are collected like shrimps, with nets, in the swamps and marshes; but they are sold to feed the mocking birds, the common cage bird in the Mexican home. Another interesting insect is a black fly (*Ephydra hians*), the larvæ of which swarm in such quantities in the waters of Lake Texcoa, that when they pupate, the pupæ are collected in bags and used as manure to fertilise the adjoining lands. At certain seasons, these flies swarm out in such clouds that they cover the railway track and stop the trains.

Another curious insect food is the caterpillar of a Hesperid butterfly, which lays her eggs upon the leaves of the *Argave americana*. These caterpillars burrow into and feed in the tissue of the leaf, and are cut out, placed in little boxes made out of a section of the thick leaf, and sold as a great delicacy.. There were many different kinds of native and tropical fruits—aninas, sapotes, alligator pears, long-stalked pink passion fruit of very poor quality, called a granada, and many other curious things. While in the offices I obtained the following reports, somewhat behind-hand as statistics, but the latest compiled, of the different products of Mexico up to 1900:—The maize crop of that year was worth 87,000,000 Mexican dollars (value, 2s.); the barley crop, worth 7,000,000 dollars. In 1899, the coffee crop, chiefly grown in the Vera Cruz district, was worth 10,000,000 dollars. In 1900, nearly 7,000,000 dollars' worth of pulque was produced from the *Argave americana*; but in the good season of 1899, 15,000,000 dollars' worth was made. Thousands of acres of the country are devoted to the growth of this aloe, from which the sap of the budding flower-stem is collected, and after being carried down the hills in pig skins, is fermented in casks. This pulque is the national drink of the bulk of the Mexicans. Besides pulque, there is also a strong spirit made from this juice, which is valued at over 4,000,000 dollars a year.

The sugar crop was valued at 23,500,000 dollars. At Gutapella Estate, near Orizaba, later on, I saw them making sugar. The machinery and crushing plant were very old-fashioned, and all the sugar turned out was made in conical loaves, weighing 18 kilos each (45 lb.); these loaves, in three grades, were more or less grey to brown in tint, and valued at from 12 to 16 cents per kilo. They also made a very strong spirit from the sugar at this mill.

The cotton of Mexico is grown in a strip of country across the centre, in the districts of Coahuila, Durango, and Tepic. At Puebla, and some of the Southern States, cotton was started a few years ago, but in consequence of the appearance of the cotton boll weevil, it was not continued. The Department have no laws or regulations against this pest, except a quarantine against any seed from Texas.

At Ameciameca, in the gardens round the palace at Chapultepec, the different public parks, Tres Marias, Tlalpam, and Guardaloupe, I spent some time with Professor Koebele studying scale insects and other pests.

Among the interesting desert plants that came under my notice was the rubber plant, known to the native as the "Guayule" (*Parthenium argentatum*); it is a stunted little shrub that grows in the northern deserts, and is collected for the large amount of rubber contained in the bark. The shrubs are pulled up, roots and all, tied up in bundles, and packed down on mules to the nearest railway station, and shipped to the United States, where the rubber is extracted. The Americans are exploiting the country, and with this wasteful method (as the guayule is a very slow-growing shrub) the product will soon be exhausted. Another is the Giant Cactus, which, growing

out of the rocks, looks, with its truncate summit, like a beer barrel in shape and size. This cactus saves the lives of many mules and muleteers, who, in the waterless desert, cut the top off the cactus with their sword-knives (machete) and pound up the pulpy interior, which is then squeezed up, and enough watery juice obtained to supply the party.

On 15th November I left Mexico City for Puebla, reaching there late in the afternoon, when I engaged an interpreter and went over the extensive markets. Next morning I called upon the Governor at the Palace, and met the Secretary of State, who gave me a letter to the chief of the Department, Fomento, and then went on to the President of the University of the State, where we went over the museum collections, and examined a local collection of insects, made by the officer in charge. He had a very fine collection of models of fruits and vegetables among the botanical specimens.

Armed with a letter to the Governor of Tchuacan, we left at 5·30 a.m. on Sunday morning, and reached the town about four hours later. The country was very mixed; patches of good land, irrigated from the mountains, and then desert limestone covered with cacti and low scrub. Met Signor Alberto Dias Cebullos, one of the largest landed proprietors in the district; he grows a large quantity of maize and barley, and, with irrigation, can get two crops a year. A white ground grub (probably a lamellicorn beetle larva) is very prevalent every few years; sometimes it destroys two-thirds of the crops by eating the roots. What is known as a fungous disease of the tassels of the maize, "Wicheley," aborts them into a white mass, which is cut off and eaten by the farmers. In the dry country the gophers (ground rats) do a great deal of damage, but cannot live in irrigated country. Large quantities of white chillies are grown here, and suffer very much from the attacks of a small weevil that punctures and spoils the crop.

From Puebla to Orizaba, after leaving the junction at Apizaco, we came through the great valley or plain surrounded with hills, to Esperanza, covered with homesteads and fields of barley. It had all just been reaped, and was made into immense stacks 4 to 6 feet in height, and from 300 to 400 yards in length, looking like ramparts of sheaves. After crossing the great mountain range, we came into the tropical orchards round the town of Nogalis, and on to Orizaba. Here I called upon the Governor, where his secretary gave me letters to the managers of the two largest plantations in the district. Going through the extensive fruit markets, I first saw mandarin oranges in this country. There was also a very thin-skinned hybrid, or sweet lemon, with a very small nipple; but it had a very poor flavour. There were large quantities of very poor quality tomatoes and Cape gooseberries on the stalls.

At the San Antino Estate I went through the coffee plantation, which was in a very neglected condition, though the trees had a very good crop; and then into the orchard, where there were a great number of oranges. I examined a great number of fallen fruits, but did not find any maggots, though it was just the place for them if there were any in the neighbourhood. Melanose was the only disease from which they were suffering; scales apparently did not thrive in the moist, humid climate. At Galupebla there was another orange plantation under similar conditions, and on the opposite side of the town I went over a tangled growth of orchard belonging to a Mexican lady, where there were a great number of different trees growing. Among them was a very curious mandarin tree, with short, sessile, stiff leaves, almost like a holly-bush, the fruit being remarkably good.

The next day went on to Vera Cruz, through rich, tropical country, with many coffee plantations along the line, most of the coffee being grown under

the shelter of large trees. In all the valleys there were banana plantations. As we came nearer to the coast the country changed into sandy flats, covered with low jungle and clumps of cocoa-nut palms. As soon as I arrived at Vera Cruz I called upon the Governor, Signor Velo, who advised me to visit the southern part of Mexico, and offered to give me a letter to his brother, who had a large ranch-farm and orchard near the town of Coatxacualus, about 100 miles down the coast by steamer.

After making arrangements for a passage across to Havana the following mailboat, seeing the British Consul, &c., I left the next day for Coatxacualus, and reached my destination on the following afternoon. Engaged an Indian to take me up to Signor Ignacio Velo's in his canoe. We started off at once, and, after some miles' paddling across the lagoons, and several miles' tramp through black mud and water, reached the homestead. I found that all the oranges in the orchard were seedlings, and one of the largest and finest produced fruit as sour as vinegar. The soil was so rich and moist, that many orange-trees were propagated by simply cutting out a large sucker, and, after trimming it and cutting off the top, driving it into the ground like a stake.

The oranges were gathered in a very primitive manner—either by climbing up a long notched pole resting against the tree, or by twisting off each fruit with a long, slender pole, with a fork at the tip. Though there were a great number of oranges lying about under the trees, I could find no traces of fruit-fly maggots. Signor Velo has about 6,000 acres of land. On part of this he runs a herd of about 500 head of cattle, and supplies the town with milk. On the swamp land he grows corral-grass, which he cuts and supplies as green fodder for the railway contractors' horses. In the plantation he has vanilla growing, some coffee, which is dried and used on the ranch, and about 700 cocoa-nut trees. About thirty peons and their families live on the estate.

One of the greatest pests on the plantations in Mexico, Cuba, Central America, and Trinidad is the leaf-cutting ant, known as the "Bibijagau," pronounced "Bébéhowie" (*Atta insularis* and *Atta cephalotis*). They form great underground chambers at the bottom of vertical shafts, often 8 feet in depth, in which they store the fragments of leaves that they cut off the trees. These nests are close together, and the excavated earth from beneath forms great mounds, with many openings. From these openings regular armies of these ants march out, and in the course of a few hours strip every leaf off an orange-tree. If in the vicinity of a vegetable garden, they reduce it to an ashheap in a very short time if once they become established, and the garden must be carefully watched. It is a most remarkable sight to come across a returning army of these large ants marching back to their nest, each with a more or less rounded fragment of leaf held by the jaws over the back, almost hiding the carrier underneath.

The chief methods of getting rid of these ants is, first, setting to work and digging them right out. At the Agricultural Experiment Station, in Santiago de Vegas (Cuba), the officers used sulphur pumps; but an orchardist said that the most successful mixture he found was boiling tar and sulphur together, and pouring the mixture down the openings leading into the nests. The ants accumulate leaves in these semicircular burrows until they ferment and produce a fungous growth upon which they and their larvæ feed. The Legislative Council of Trinidad passed an ordinance which enabled the Governor to declare certain districts infested with this pest, to enable planters to take measures for their destruction.

Returning to Coatxacualus, I took the train crossing the isthmus to the town of San Lucrecia, situated in the centre of a great marshy district, where, down the river, there are a number of American companies starting sugar plantations. From San Lucrecia I caught the branch train that started for Cordoba at 5 a.m., and reached Vera Cruz at dark the same day, travelling across a great deal of low, marshy land.

I left Vera Cruz on 28th November for Habana, Cuba. When coming on board I noticed a large number of cattle and horses on board. The cattle were smothered with the blood-sucking Horn Fly; and apparently a considerable number came on with them, and reached Cuba in due course. Two days out we spent a very unpleasant day at anchor off the low-lying town of Progresso Yucatan. This is the chief port for the export of the sisal hemp, the fibre of the aloe *Argave rigida*. We shipped some hundreds of bales, and a quantity of tickory, the gum of one of the *Sapotacea*, which is collected by a syndicate over a very large portion of Yucatan, and shipped to New York, where it is used as the chief ingredient in the manufacture of American chewing gum. On the 2nd December arrived at Cuba, and, as soon as I had landed, went to see the British Consul. He informed me that Jamaica had a strict quarantine against Cuba for yellow fever, and it was also probable that, after the recent outbreak of yellow fever at Barbados, no ship would call there. From there went to the Government offices, and called upon the Under Secretary of Agriculture, who gave me a letter to the Director of the Agricultural Experiment Station at Santiago de Vegas, and others to the Museum. At the Experiment Station, about 10 miles out from Habana, I met Mr. Crawley (the Director), who introduced me to his staff. Messrs. Horne and Howser went over the collections and pests in their orchards with me. No fruit-fly is recorded from the Cuban orchards, but there are several destructive orchard pests, among which may be noted the Orange Weevil, which feeds upon the foliage of the orange, and lays its eggs upon the leaves, which it curls over and gums together, just like our *Leptops hopei*, the apple-root weevil. The larvæ feed upon the roots, and often kill the trees. This handsome green weevil (*Pachnæus curescens*) is a native species, and is quite common in both field and forest. Among the most common scale insects of the orange is a very large lecanid (*Lecanium*, sp.?), which attacks the bark and injures it in much the same manner as woolly-blight damages our apple-trees. Two others, purple and long scale, are common. Melanose is very prevalent in all the citrus orchards. I examined some of the oranges and grape fruit having the sheltered half almost ink black, but it did not appear to injure the quality of the fruit. Most of the citrus trees have been brought from Florida, and are grafted on the wild sour orange that grows in the forest. Besides the tangarines (as mandarins are known throughout the West Indies) the most profitable fruit is a pomolo, known as the "grape fruit." It differs from our pomolo in having a much finer skin, and only the slightest bitter taste. Two varieties are grown here. The Royal, which is the original Cuban type, is small, but with a fine skin and excellent flavour; the larger one has been introduced from Florida, where immense numbers are grown, for it is the most popular of breakfast fruits, eaten with sugar, in the United States. At the time of my visit they were bringing about 4 dollars a case, and in some of the fashionable hotels in New York and Boston, they charge from 50 to 75 cents for one for breakfast. Altogether there is about 400 acres of orchard (chiefly citrus) within a few miles of the Experiment Station, most of it in the hands of Americans.

The growing of tobacco is one of the important industries of this part of Cuba, and one of the most valuable; and though it requires a lot of attention

[*Photo. by J. W. Cleary.*

A Native's Hut and Banana Plantation in Jamaica, W.I.
The greater portion of the eighteen million bunches exported last year (1907) are grown in this manner.

and watering, nearly all the natives grow some tobacco, and several firms have large areas under cultivation. The most valuable tobacco, the wrapper leaf, is often grown under shade, or covered with cheese cloth, as it is thus protected from hawk-moth larva, and, also, the breaking of the direct rays of the sun keeps the ground moist for a much longer time after watering, so that the growth is much more vigorous than when grown in the open. At Messrs. Sylvester, Stein, & Co.'s plantation there were 30 acres of wrapper-leaf tobacco growing under cheese cloth, over regular posts and wire supports about 8 feet in height, and all the doors were covered with the same material, so that it was a perfect enclosure. All this is carefully watered, and each leaf dried separately, hung over poles in the tobacco house, and dried without artificial heat. Mr. Horne informed me that each plant was estimated to be worth 10 cents. Water is obtained from wells, but has to be pumped up about 80 feet all over this district.

There are cocoa nut palms growing in most parts of the island, but the larger plantations are in the south. One of the most serious troubles of the cocoa-nut palm is a bacterial disease, known as the "bud rot disease"; it attacks old trees and very young ones, and when once infected the tree soon dies. It is a well-known disease in many of the West Indian islands. There is a very large water bug (*Belostoma*, sp.), which is very common in the lagoons and waterholes; in the summer months it comes flying round the light and the lamps in the houses at night. For some unknown reason the natives believe that this bug is the cause of "bud rot" in the cocoa-nut palms.

There are many large sugar plantations in different parts of Cuba, and though during the many years of civil war numbers went out of cultivation, and the old mills fell into decay, during latter years some large areas have been planted. I visited one of the older plantations at Güines, La Providencia, where they have been growing sugar-cane for the last hundred years without any fertilisers. This plantation is one of the largest of the old plantations, and is worked on the old Cuban plan with colonos. The cane land is let to farmers—colonos—who till the land, plant and cut the cane, and after it is crushed, are paid in sugar as their share of the produce. This estate consists of 800 caballarias (33⅓ acres to a caballaria), or about 26,300 acres. Most of the cane is allowed to grow from eight to ten years without replanting, and the percentage of sugar in the juice ranges from 9 to 12½ per cent.

At the invitation of the manager of the United Fruit Company, I went from Santiago de Cuba to Banis, where the company have a sugar plantation, worked on modern plans, of about 20,000 acres of cane, 60 miles of permanent railway lines, and an up-to-date mill. Chilperic, the adjoining estate, has 40,000 acres of sugar-cane. The country is very flat, chiefly black soil, and was originally covered with a dense forest. The company first started this estate to grow bananas for export to the States, but for some undiscovered reason bananas would not thrive, so they placed it under cane. The average rainfall is 60 inches, but last year only 23 inches had fallen, and the whole district was suffering from the drought. They estimated their sugar crop at about 30,000 tons of sugar, all of which is shipped direct from Banis to New York, New Orleans, and Baltimore. There are also some large sugar plantations in the Cienfugeos district.

At the town of Güines, which I visited with Mr. Horne (Pathologist at the Experiment Station) we went over the great centre of the vegetable-growing industry, under irrigation from a large river that comes directly out of a limestone hill, and the water from which is carried in channels all over the rich black soil. An immense number of tomatoes are grown here by the

Cuban farmers, who sell them at the packing-sheds in the town. The American packers buy them by the bushel, at about 1 to 1½ dollars at this time of the year, and the tomato season lasts from May to December. The tomatoes are green and hard when gathered, and graded into three qualities; each is wrapped in paper and packed in two rows of punks, separated by a thin wooden frame. These crates are all imported from Florida. All these tomatoes are sent to the large towns of the United States.

There are hardly any insect pests upon the tomatoes, and the only fungus is one that causes discoloured black patches on the underside of the fruit, which is said to be only found when the tomatoes rest too long on the wet ground. Besides the tomatoes, great quantities of onions, cabbages, and green peppers are grown on this rich land.

At the Agricultural Experiment Station I made an interesting collection of the insects and pests of Cuba. Dr. Mayo, in charge of the Stock Division, gave me some interesting information regarding the stock diseases in Cuba. One of the worst is thrush, which attacks the frog of the forefeet of both mules and horses, and causes them to rot. Their chief treatment is dressing them with creoline or carbolic, and packing the damaged tissue. Tetanus is also very common all over Cuba, and attacks both man and animals. In many of the smaller towns the children run about naked up to 5 or 6 years old, except that they all wear some kind of boots for fear of lockjaw. Mules and horses often contract tetanus from injuring their feet. The treatment for stock is strychnine and rest. Several species of tick are common on cattle, but do not affect the horses. Fowl Tick (*Argas Americanus*) is common in many fowlhouses, and we found specimens in the fowl roosts at the Experiment Station.

There is no regular museum in Habana, but through the kindness of the Secretary of Agriculture, who gave me a letter of introduction to the Director of the Instituto de Secunda Ensenanza di la Habana (the High School and College), I was able to examine the Gundlach Collection of Zoology. This fine collection of the zoology of Cuba was made by Dr. Gundlach, in 1839. The insects, pinned in small glass-topped boxes that have been carefully sealed, are in excellent preservation, and the great collection of land shells is very fine. I also visited Belen Church, where there is a very large Catholic school, to see one of the priests, who had charge of a collection belonging to the school, but he was away and the collection shut up till his return.

I also visited the fruit markets in Habana, where a great number of bananas are sold, many of the bunches getting quite black before they are eaten. Purple scale was common on the oranges, and both in the markets and street-stalls oranges were usually peeled before they were sold, a thing I never saw anywhere else.

Great quantities of chillies, green peppers, and onions are in all the Cuban markets.

I left Santiago de Cuba for Jamaica on 23rd December, in the s.s. "Oteri," and early in the morning was in sight of Port Royal, landing about 10 o'clock at Jamestown. As it was Christmas Eve, I could not find anybody in their office for the next two days; but as soon as the Government offices were opened, I called upon the Colonial Secretary, who gave me letters to the Hon. J. Faucett, Director of the Botanic Gardens and adviser on agricultural matters, and also arranged for me to get a free pass on the railways while in Jamaica. To Mr. Faucett I am indebted for a great deal of valuable information about the products and pests in Jamaica. Since 1901, fumigation of all imported plants has been enforced under a proclamation of the Act of

[*Photo. by J. W. Cleary.*

Collecting the Bananas at Port Antonio, Jamaica, W.I., for export to the United States.

1884, Seeds and Plants Importation Law, first brought into existence to deal with the coffee leaf disease of Ceylon. A portion of this Act has since been modified to allow the authorities to fumigate plants with hydrocyanic acid gas for fungous diseases. There are six of these fumigators in use at the Botanic Gardens, wharves, and Post Office. In the Hope Gardens was planted one of the original bread-fruit trees obtained by Captain Bligh, and from it great quantities of bread-fruit have been planted all over the island; and bread-fruit is one of the foods of Jamaica. A fine collection of Algerian date palms are growing in the gardens, but the foliage suffers much from a leaf rust (*Puccinum phenociæ*). Cocoanut bud rot disease is common in the plantations, generally starting on the flower bud and then extending to the terminal leaf bud; prompt spraying with strong Bordeaux mixture is said to check it.

Experiments are being carried out in growing vanilla, and with ordinary care it does very well. The Seychelles Islands, some years ago, were the centre of this valuable industry, but a leaf fungous disease broke out and destroyed all the plants.

As in every place, the cultivation of cotton has been pushed along the last few years, but in consequence of the cotton moth *Aletia argillacea* doing so much damage to a large experiment plot planted last year, the industry had a serious set back.

Mr. Faucett also gave me some reports and information regarding the fruit-fly in Bermuda, and the methods adopted to get rid of it in that country; these will appear in my report upon the Fruit Flies. Mr. Faucett gave me introductions to several of the leading planters in different parts of the island, and on the following afternoon I left by train for Port Antonio, the head-quarters of the United Fruit Company, which controls the whole of the banana trade, one of the most important industries in the island. The greater part of the fruit is grown by the negroes, who sell them to the agents of the Company. In 1906, 16,000,000 bunches of bananas were shipped from Jamaica, nearly all of which went into the United States. Each bunch consists of from twelve to nine hands; anything under nine hands is called a half-bunch. In the season, four or five boats load up with bananas every week from Port Antonio, and the estimated value of the banana was nearly £1,000,000. Sulphate of ammonia is used by the large growers as a fertiliser for bananas.

At the Hon. H. Cork's estate, at Burlington, I saw his plantations of cocoa-nut palms, just recovering after the great hurricane of 1903, when nearly all the old palms were destroyed. Mr. Cork lost the best part of 24 acres of full-bearing trees. This is one of the most profitable crops grown, cocoanuts being worth up to 11s. per hundred. Last season 11,000,000 cocoa-nuts were exported, at an average value of 8s. per hundred. From Burlington I took the train to Bog Walk, and the following morning left for Ewarton and coached across the range to the Hon. J. V. Calder's estate, at Worthy Park. Here I went over one of the oldest plantations on the island, where all kinds of different tropical crops are grown.

A considerable amount of cocoa is grown here, and I spent the greater part of the afternoon riding through the cocoa plantation. The cocoa tree, for the first two or three years of its life, is a very delicate tree, but when once established, is very hardy. It is, however, subject to some serious diseases, the worst among which is canker. This commences as a blister on the trunk, or main branches; a quantity of gum accumulates under the blister, and the bark decays; the treatment is to cut away all the diseased bark and paint the wound with a mixture of tar and fish oil. Black rot attacks the pods, and if they are not cut off it spreads into the growing wood, from which the

flowering buds develop, and thus, if not taken in time, will cause the flower spurs to die out and spoil the next year's crop. Thrips is an insect pest that develops among the foliage, and then attacks the pods, causing them to abort and wither, so that half the pods will have no seeds. The rats sometimes do a great deal of damage to the cocoa by gnawing holes in the pods to get at the seeds; and several of the woodpeckers have learnt how to drill holes into the pods and extract the seeds.

The trees are planted from 12 to 18 feet apart, and should be grown under shade for the first five years at least. At ten years old they can shade themselves, but among the planters there is a great amount of controversy and argument as to whether these trees should be grown in shade or in the open. They bear flowers, which spring directly from the trunk or main branches, when eighteen months old; there are always an immense number of pods that never reach maturity, as nature throws off the superfluous ones. The pods, when full grown, are cut off and the beans shelled, fermented in a vat, then taken out and spread on a drying-roof; from this they are taken and placed in a cylindrical drum or roaster through which hot air is forced, and thus dried, they are ready for market. All the plantation negroes are paid by piece-work, and the average wages are about 1s. 6d. per day. The cocoa crop of the West Indies in 1905–6 was valued at £1,500,000. It is the sole crop of Granada, in Trinadad; it is worth more than double the output of sugar, and is grown in St. Lucia, Dominica, and St. Vincent. The average yield in Granada is 4 bags of 196 lb. per acre, or equal to 784 lb. per acre. In 1906–7 the quantity of cocoa exported from Jamaica was 50,057 cwt., valued at £190,216. At Worthy Park there is a considerable acreage under sugar-cane, some of which is crushed for sugar, though all the profits come from the distillation of rum. Mr. Calder crushes about 500 tons of sugar every season.

From Ewarton I went down to Spanish Town by train, and then took a coach to the Hartlands Fruit Company Estate. Here the manager, Mr. Wigens, has 190 acres of citrus trees, grape fruit, mandarins, and oranges. Among the latter are Washington Navels, though they consider the Bahia Navel is a sweeter fruit. The King orange is a very coarse, rough-skinned fruit, like a small rounded mandarin, and though an orange it tastes like a mandarin, and is said to have been introduced from Florida. The grape fruit pays best of all his crops, and he is now shipping a good number to the London markets. This country is very flat, heavy land, and was originally planted with bananas, but the soil did not suit them. The trees appear to be planted rather low in the ground and suffer a good deal from collar rot, which not only attacks the base of the stem but also often high up on the side of the trunk. This they treat with tar and fish oil, or Jay's Fluid, after cutting off the diseased bark.

There was no red scale, but *Aspidiotus citri* and *Aspidiotus fici* were common on the trees and fruit. Melanose disfigured a great deal of the fruit, but was not looked upon as a pest, for the English buyers do not take any notice of it, as long as the fruit is well grown. Last year Jamaica exported 32,000 packages (Florida cases) of grape fruit worth 6s. a package and 55,000 oranges, worth about 2s. 6d. per hundred.

From Hartlands I went on to Montego Bay on the north end of the island, and another port where bananas and other fruit are sent on to America. Stopping on the road at Mandeville, I saw quantities of the large scarlet loose-skinned mandarin that is peculiar to that district, and is known as the Mandeville mandarin.

[*Photo by J. L. Maduro, jnr.*

New Quarters, with wire gauze to protect the American workmen against the fever mosquitoes Pedro Miguel, Panama Canal.

I returned to Kingston on the 2nd of January, and took my passage to Barbados, for which I left the following day, meeting on the steamer Messrs. Williams, Faucett, and Savage, the three delegates to the Imperial Agricultural Conference to be held in Barbados on the 14th. We arrived at Colon, on the Panama Canal, on the 6th, stopping there two days, one of which I spent at Colon and Panama markets, where the most striking commodities were the number of yams, Jamaica mandarins, Martinique bananas, and the small yellow thick-set banana, known as the Chinese banana.

On the 13th we anchored off Trinidad, where we were under strict quarantine with the shore, for a number of people had died from yellow fever only a few days before, and Trinidad was plague-stricken. The following morning we sighted Barbados, and anchored off Bridgetown at 2 o'clock. The delegates from Jamaica introduced me to the officers of the Agricultural Conference, who very kindly placed me on the same footing as the official delegates, and when I went ashore with them met the Imperial Commissioner, Sir Daniel Morris, who, next morning, had me elected an honorary member of the Conference, with all their privileges.

At this Conference I was enabled to meet the leading officials from all the West Indian islands and British Guiana, and could learn what it would have taken me months to do if I had had to travel over the islands. From the 15th to the 20th instant I attended all the meetings of the Conference at Bridgetown, and at the request of the Chairman gave an address to the members on our work in Australia.

Here I met Mr. H. A. Ballou, Entomologist to the Imperial Department of Agriculture of the West Indies, and we went into the question of cosmopolitan insect pests, the diseases of plants, and the value of parasites. Among some of the interesting problems dealt with at the Conference, the following might be noted:—Barbados is noted for its experimental work in seedlings of sugar-cane, and 25 plantations have an acre set aside as an experimental plot for seedlings. The crushing of the cane till recently has been done after the old fashion, with windmills, and I was informed that at present nearly 75 per cent. of the cane is still crushed with vertical or horizontal rollers worked by windmills. Several companies have now started on a co-operative basis, and are installing modern machinery at Carrington and Bulkley sugar mills. The growing of cotton is one of the most flourishing industries in Barbados, as they can grow the best Sea-island varieties, worth from 1s. 6d. to 2s. 6d. per lb. Nearly 7,000 acres are now under cultivation, estimated to be worth £120,000. A co-operative cotton factory was opened in 1903 and completed in 1907. The management buy anything from 100 lb., gin and bale it in 500 lb. bales. They claim that this is the largest Sea-island cotton mill in the world. There is a considerable acreage of cotton at the islands of St. Vincent, Montserrat, Nevis, and Anguilla, where it is a very valuable crop, but at Demerara and Trinidad it will not thrive.

The pests of cotton are numerous. Four different moth caterpillars attack the crop; the two cotton worms, *Aletia argillacea* and *Aletia lusidula*, are common species; while the cosmopolitan boll moth, *Heliothis armiger* and *Laphygma frugiperda*, attack the cotton bolls. Egg parasites attack the first two, but are never in sufficient numbers to do much good. The general treatment is to use Paris green dry, in bags of ticklingburg, dusting it over the foliage. They also use tin shakers and powder guns, but have not tried liquid sprays or spray pumps. Several of the large paper-nest wasps (*Polistes*, sp.), popularly known in the West Indies as "Jack Spaniards," and a ground Carab beetle (*Calasoma*, sp.), are known to kill a good number

of these caterpillars. The Cotton Aphis (*Aphis gossypii*), another cosmopolitan pest, is one of the worst enemies of the cotton-plant and difficult to deal with. There is a leaf-blister mite forming galls upon the leaves, and *Lecanium nigrum* is a common scale upon cotton. The Rod Maggot lives in clusters under the bark of the stems of the plant, which, however, has been first damaged with a bacterial disease known as "Brown Elbow," so that it may possibly not be a pest in the strict sense of the word, though always found in damaged tissue; it is the larva of a *Cecidomyia* fly (*Porricondyla* (*Epidosis*) *gossypii*), or gall-gnat. There is a second *Cecidomyia* which has recently appeared in Antigua. This species lays her eggs in the flowers of the cotton-plant, causing them to wilt and drop off, presumably from the larvæ feeding upon the pollen. There is also a form of *Anthracnose*, which sometimes does a great deal of harm to the cotton bolls.

In British Guiana a considerable quantity of swamp rice is grown. Last year 30,000 tons of rice were harvested, much of which were exported to the other West Indian islands.

At the Conference very little information was available of the commercial value of West Indian rubber. In the President's address he stated that thirty-three estates were planting rubber, and it was estimated that 300,000 trees had been planted; that Castilloa scrap rubber brought 3s. 2d. per lb. and sheet rubber 4s. 3d., but that grown in Tobago realised up to 5s. Ten of the estates were planting Para rubber (*Hevea*) and Lagos silk rubber (*Funtumia*). In Demerara they are planting both *Hevea brasiliensis* and *Castilloa elastica*. In Jamaica I found them planting *Castilloa* as shade trees for the cacoa, and in St. Lucia and Dominica it is used in the same way.

At the island of Montserrat, famous for its lime-juice all over the world, one company has a plantation of 2,000 acres of limes, where they manufacture lime-juice and citrate of lime. Lime products to the value of £6,883 were exported last year. Dominica also does a very large trade in lime-juice.

Chionaspis citri is a very destructive scale insect on the citrus trees in these islands; and as lime-trees are very thorny, and are planted close together on often very rough land, the growers say that it is impossible to either spray or fumigate at a profit. The question of parasites to destroy this and other scale insects was brought up at the Conference, and many questions were asked. One planter has a remarkable remedy or preventative for this scale, which is to plant Bengal beans in his orchard, and allow them to climb all over the tops of the trees; and, according to the planter, no scale could be found on these trees. But other delegates doubted very much whether there would be any fruit on trees grown under such conditions.

The only island where tobacco is grown to any extent is Jamaica. Last year £21,809 worth of tobacco leaf and cigars was exported; but there is also a very large local consumption. One of the sights of the Jamestown market is the tobacco stalls, where great balls of tobacco, made up into rope-like cables, are sold to the negroes.

While the Conference was at work we visited a number of estates, and after its business was concluded, and the delegates had returned home, I made several trips over the island with Mr. Bovell, the Director of Agriculture, and Mr. Ballou, the entomologist. All the work in the West Indies is done by negroes, men and women working alike in the fields and plantations, while on the mainland, at Demerara, all the labour is done by imported Indian coolies; and there are 71,000 on the plantations, and 63,000 at other work.

[*Photo. by J. W. Cleary.*

Type of the Sugar Mills on the Sugar Estates in Jamaica, West Indies.

At midnight on the 28th of January I left Barbados for Southampton, and arrived there on the night of 9th of the following month. On the following morning I called upon Mr. Coghlan, at our Agent-General's office, and asked if there had been any instructions sent for me from any of the Australian States I was representing, and on the next morning called upon the Agents-General of Queensland, Victoria, and South Australia.

My next work was to get into touch with the authorities at the Natural History Museum, at Cromwell-road; and, after meeting Messrs. Waterhouse and Kirby, who took me all over the offices and introduced me to the staff, I set to work and examined many of the economic collections. With Mr. Austin (in charge of the Diptera) I hunted through the fruit-flies and other injurious species, but found few named specimens of our particular fruit-pests. Whenever not otherwise engaged, I spent my time at the entomological rooms of the Museum, examining specimens and making notes on the collections; and each officer on the staff gave me every help in his power. With Mr. Roland Turner and Colonel Bingham I went through some of the hymenoptera. Mr. Distant showed me many of the unique forms of Australian cicadas in the collections, Mr. Kirby looked up the locusts and grasshoppers, and Mr. Gahan the beetles.

At Wye Agricultural College, in Kent, I spent a day with Mr. Theobald, the Principal. He is one of the leading authorities on the Mosquitoes, and has published the two Economic Entomology reports in the British Museum. He took me through the laboratories and buildings, and then over the farm and orchard. Here they have a large dairy, but the cows under shelter did not look so happy as ours. I noted that they still use underground silos, and the milking sheds were not up to ours. Some interesting experiments in testing the value of the different cattle foods were being carried out in the dairy herd. This being in the hop country, they had an up-to-date outfit for drying hops with heated air.

The orchard is on poor, chalk land. The pears and apple trees are planted 10 feet apart, pruned low, and looked very well. No blight-proof stocks are used in English orchards, and in consequence, in all the old orchards, American blight or Woolly Aphis is common, both upon the roots and branches. Most of their trees are grafted upon Paradise stocks. Paraffin (low illuminating oil, worth 4d. per gallon), mixed with fish oil and caustic soda, is the chief wash used in this orchard. One of the worst insect pests of the pear is "the Pear-bud Fly" (*Diplosis*, sp.), which lays her eggs in the calyx of the freshly-formed fruit. The little maggot gnaws the tissue, causing them to swell out and finally drop off. The gooseberry-bud mite is also a serious pest to currants, infesting the buds and causing them to drop off. Canker is very common in the apple orchards; and wherever the bark is bruised or damaged, canker spores infest it, and do more or less damage. The Apple Psylla (*Psylla mali*) is another serious apple pest, and the Saw Fly larvæ attack the pears.

Mr. Salmon (the mycologist) showed me a number of interesting specimens of fungous diseases. Among the serious pests of the potato he pointed out "Black Scab" (*Chrysophlyctis endobiotica*, Schilb.), that was only introduced into England about 1895, and has now spread over nine counties of England and Scotland. It could be very easily introduced into Australia with seed potatoes.

American Gooseberry Mildew (*Sphærotheca morsuvæ*, Bull.) is a well-known pest in America, and is said to have been introduced into the gooseberry orchards of England about eight years ago. In that time it has spread all over England and Ireland, and has appeared in different parts of the Continent.

It should be famous, for it has been the cause of the British Board of Agriculture passing the first Vegetation Diseases Act into law, in order to deal with this pest. Notices under this Act have been posted up all over the country districts, calling attention to the danger of it spreading, and the means to check it.

At Watford, at the request of Mr. F. Cooper, I visited his laboratories, and saw his methods of working out the life histories of the different species of cattle ticks, and his apparatus for making micro-photographs from the tick itself. The main laboratories of Messrs. Cooper and Son are at Berkhampstead, but I was unable to accept their kind invitation to visit them.

I spent two days in Liverpool with Mr. Robert Newstead, who is the best known economic entomologist in England, and is in charge of the very important entomological investigations at the Liverpool Tropical School of Medicine, attached to the Liverpool University. The medical side of entomology was demonstrated a good many years ago, when it was proved by Professor Grassi in Rome, Major D. Ross in Africa, and several other investigators along the same lines, that mosquitoes had the power, when biting people, of leaving behind in the blood a micro-organism that, multiplying with marvellous rapidity, disorganised the blood to such an extent that it brought about malarial fever. These discoveries opened an immense field of original research; and it is now proved beyond a doubt that all the malarial fevers and the dreaded yellow fever, that bugbear of the West Indies and South America, are transmitted to man by the bite of mosquitoes. In many cases the exact species of mosquito is known, and within the last ten years thousands of lives have been saved by the practical application of this knowledge. *Stigomyia fasciata*, the yellow fever mosquito, has been carefully studied, and its life history ascertained, so that we know where to look for and destroy it. In the last outbreak in New Orleans, the energetic methods of destroying all stagnant water and fumigating each room stamped out the fever in a very short time. In Cuba the same thing has taken place since the American occupation, and at the Panama Canal, one of the most deadly places in the world twenty-five years ago, the methods of the American engineers have now made it one of the healthiest. One of the important missions of the workers at Liverpool is to discover some means to deal with the "Sleeping Sickness" of Central Africa, caused in a similar manner by the bite of a large blood-sucking fly (*Glossina pulpalis*), a closely-allied species to the better known "Tsetse Fly," which causes the death of so much stock in many parts of Africa. The organism carried by this fly is known as "*Trypanosome*," and natives attacked by this disease seldom recover. The disease has been spreading rapidly the last few years, because if a native comes out of an infested area of sickness, with his blood teeming with these micro-organisms, he will transmit the disease to this particular fly if it happens to bite him; while, if in clean districts, not having imbibed infected blood, it would not be able to reproduce the disease. The Government officials in some districts have formed a regular quarantine line, and all natives are carefully examined, and if they show any swelling of the cervical glands (one of the most certain evidences of the disease), they are not allowed beyond their own district. Hundreds of thousands of natives have died in Africa during the last ten years, particularly those living in the low-lying or swampy lands; and it appears at present as if the survivors of these districts will have to be removed to higher lands away from the fly-haunted swamps, unless some simple method of exterminating the flies can be discovered. The whole trade of Central Africa is disorganised by this

insignificant but deadly organism, and the Liverpool merchants have so much at stake that they are always ready with the necessary funds to assist the scientific workers in the Tropical School of Medicine. In fact, a movement was on foot when I was there to raise funds to endow a chair of Economic Entomology and Zoology, which will be the first of its kind in Great Britain. Mr. Newstead has very fine laboratories, fitted with all modern appliances for dealing with entomological work, and he also gives series of lectures to the students.

I also visited the Tropical School of Medicine of London, with its headquarters at Woolwich in conjunction with the Hospital for Seamen. Here I met Colonel Alcock, late of the Indian Museum at Calcutta. This is not so well endowed as the Liverpool Tropical School of Medicine, but they have a fine teaching staff and good laboratories. Meeting the Hon. C. N. Rothschild in London, I spent a day at their private museum at Tring, going through his great entomological collections with his curator, Dr. K. Jordan. Here is a priceless collection of the great bird-winged butterflies (*Ornithoptera*), many of which come from North Australia and New Guinea, and the finest collection of fleas (*Pulicidæ*) in the world, for Mr. Rothschild is the greatest living authority on fleas at the present time. This is another important group of insects from an economic and medical point of view, for it has been proved that fleas infesting a rat affected with bubonic plague can, if it bites a man, infect him with the organism that is responsible for the plague. It is also stated on good authority that leprosy can be transmitted in the same manner by fleas.

Two days were spent at the Hope Zoological Museum at Oxford University, under the charge of Professor Poulton. Here are a great many types of Australian insects, described by Professors Westwood, Hope, Pascoe, and other entomologists. Among them is one of the first collections of Scale insects, started by Westwood. Commander J. J. Walker, R.N, who was stationed in Sydney some years ago, is an honorary curator in the Museum, and gave me a great deal of assistance in looking up the Westwood types. Among these were Westwood's original notes on the Mediterranean Fruit Flies, bred in London, in 1848, and species of *Dacus* (from Brazil, Ceylon, and India).

There is also a very interesting collection of Thrips (Black Fly), from Ceylon, made by Dr. Thwaites, the first Director of the Botanic Gardens at Peradenyia, Ceylon. Among other interesting economic notes I found specimens of *Icerya purchasi*, "The Cottony Cushion Scale," upon the leaves of acacia, with the following note: "The coçci, forming rows with the young like acari, on the outside of the waxen cover.—J. D. Hooker, Horticultural Society, March, 1874, South Africa." Now this famous Mealy Bug was not known as a pest in California till some years after this date, though found in San Mateo as far back as 1868. In South Africa it had been recorded in 1877, when Professor Trimen mentions he had seen it in 1873, so that these specimens are probably some of the earliest collected, four years before it was discovered and named in New Zealand.

Another day was spent at the Zoological Museum at Cambridge University, with Dr. David Sharp, where there is another important entomological collection, containing types of Australian insects. Here I found, among an African collection of Diptera, several unnamed species of fruit-flies, belonging to the genus Dacus. They also had the Cherry Fruit Fly (*Rhagoletes cerasi*), bred from fruit in the south of England. At the Agricultural Branch I met Mr. Biffin, in charge of the botanical work, interested in the

hybridization of wheat. Here also is found the immense collection of *Termitidæ* (White Ants), made by Mr. Haviland, and afterwards worked out by him and Dr. Sharp, said to have cost some thousands of pounds to get together.

Through the kindness of Mr. G. H. Verrall, the well-known British authority on *Diptera* (flies), I was enabled to go through his great collection, which contains the Bigot Collection, bought by him some years ago, and in which there are a great many types and Australian species. Among these the fruit-flies were well represented, as Bigot had many specimens from the east, and I was enabled to make many notes upon species, and the localities in which they were found.

At the London University, Gower-street, I went over the Zoological laboratories with Professor J. P. Hill, late of the Sydney University, and saw their teaching collections. At Nottingham, I met Professor Carr at the University, where there is an agricultural branch of investigation, and, also, the Rev. A. Thornly, who is in charge of the nature-study work in all the schools of several of the midland counties; and he wanted to know all about our work and methods in Australia.

I attended a meeting of the Linnean Society of London, and heard a very interesting paper by Mr. Sutton on the development and origin of the cultivated potato, with a suggestion that it might be possible to produce a variety which would withstand the potato blight.

Later on, I attended the monthly meeting of the Entomological Society of London, where I met a number of the leading British entomologists, and, at the request of the President, made a few remarks on our work in Australia.

At the request of the Victorian Agent-General (Mr. Taverner) I spent an afternoon with Mr. F. H. Middleton, Entomologist and General Adviser to the Board of Agriculture, who was rather despondent as to the attitude that the ordinary English horticulturist takes towards spraying, fumigating, or otherwise dealing with insect pests. On the question of rabbits, he said that the Danyz rat virus has worked well in London in destroying rats, and "Rattin," a German preparation is also used. He gave me a copy of the Acts to deal with vegetable and plant diseases, and other reports. The Act first passed is entitled "An Act for preventing the introduction and spreading of Insects destructive to Crops," 1877, August, and was passed at the time when the Colorado Beetle, or Potato Bug, of America (*Doryphora decemlineata*) was discovered in England, introduced with a cargo of American potatoes. The final section reads:—"This Act may be cited as the Destructive Insects Act, 1877." Last year (4th July, 1907) the second one, "An Act to extend the Destructive Insects Act, 1877, to all Pests destructive to crops, trees, or bushes," was passed. The first section is as follows:—"(1.) The Board of Agriculture and Fisheries may, for the purpose of preventing the introduction into Great Britain of any insect, fungus, or other pest destructive to agricultural or horticultural crops, or to trees or bushes, and for preventing the spreading in Great Britain of any such insect, fungus, or other pest, exercise all such powers as may be exercised by the Board in relation to the Colorado beetle under the Destructive Insects Act, 1877; and that Act shall apply accordingly, as if in that Act the expression 'insect' included all such insects, fungi, and other pests, and the expression 'crop' included all such crops, trees, and bushes."

This is the first comprehensive Act of this kind passed in Great Britain, and though I am told that it was passed to deal with the American Gooseberry Mildew (*Sphærotheca mors-uvæ*, Berk.), it will be seen to include all pests.

The Board of Agriculture and Fisheries publishes a number of leaflets on agricultural matters, which are sent post free to all who ask for them.

On the 11th March, having concluded my work in the museum, I left for Paris, arriving there the same evening. I engaged an interpreter and guide, and presented my credentials to Professor P. Marchal, Entomologist to the Department of Agriculture, who placed himself at my disposal all the time I was in Paris. He has very good working laboratories, and a fine collection of economic specimens of the pests of France. *Dacus oleæ* is common in the south of France, and about the district round Marseilles it often does a great amount of damage to the olive crop. The Mediterranean Fruit Fly (*Ceratitis hispanica*), as it is called all over Europe, though identical with our introduced species, has been found on several occasions in the orchards close to Paris; but Professor Marchal informed me that they die out every winter, so that it is from further importations of infested fruit that the fresh broods appear. He has done some interesting work on *Polymorphism*, a most interesting fact in the development of a number of distinct eggs from the single ovum deposited in the body of a caterpillar by micro-hymenoptera that are parasitic upon them. He has illustrated the development of a species of *Encrytus*, showing how, through a series of fissions, a single egg, after being deposited in the caterpillar's body, finally separates into 100 eggs, from which emerge larval wasps, each spinning a separate cocoon, and producing a tiny parasitic wasp. This is a phase in the life of internal parasites that has been only quite recently understood. Professor Marchal has a number of fine coccids from all parts of the world, among them some very large species of the greasy wax scales (*Ceroplastes*) from Africa.

The other branches of the Department of Agriculture are in the same building, where there is a display of botanical specimens, chemical laboratories, and a collection of agricultural implements. There is, too, an advanced Agricultural College, where Professor Marchal delivers thirty lectures during the term.

From here I visited the Jardin de Plantes, going through the splendid galleries of the different floors of the Natural History Museum, where, in the entomological section, the nests of termites, wasps, and other insects are beautifully arranged.

In the laboratories I met Dr. Bouvier, who placed an assistant at my disposal, and, with him, went through the remains of the Meigen Collection of Diptera. Part of this collection was destroyed by fire, and another portion is in the Vienna Museum. There were no named specimens of fruit-flies among the *Trypetinæ*. Among other flies, I saw the difference between two species of leaf-mining flies, one of which is such a garden pest in Australia. *Phytomyzia affinis* has the tarsi white, while the second species (*P. nigripes*), said to be our common species, is somewhat larger, and has black tarsi. There are twelve described species of the genus *Lonchæa*, an interesting group, for some of them are supposed to damage ripe fruit. After examining their collection of *Coccidæ* (scale insects), I went on to the Pasteur Institute, where I found the officer in charge of the biting flies, and other insects that cause fevers, sleeping sickness, and other tropical diseases.

The evening was spent at the rooms of the Société Entomologique de France, of which I have the honour to be a member, and where I attended the monthly meeting. I met the President, Abbe Joseph de Joannes, and gave the members a short address on enotmological work in Australia.

After some work with Professor Marchal, we went to Professor Giard's laboratories, and, in the absence of the Professor, were shown round by Dr. Maurice Caullery, and the work on internal parasites and insects was explained.

From here we went on to the Sorbonne, and saw the museum and teaching collections, where the marine specimens are finely prepared by one of the assistants, with his special solutions, and finally placed in 5 to 10 per cent. formalin.

The next day we went over the experimental plots of the Luxemburg Gardens; then through the hot-houses, and saw the methods of pruning and spraying fruit-trees that are trained over walls and trellis. Then on to the laboratories of the Vegetable Pathologist (Professor E. Griffin), who also has charge of the Experiment Station at Grenoble. He has very complete laboratories, in front of which is a large garden where experiments are carried out.

At the School of Practical Medicine we called upon the famous zoologist, Dr. Blanchard, and examined his collection of mosquitoes, internal parasites of animals and man, and fleas. Dr. Emile Brumpt, one of the authorities on ticks, showed us his collections, and was anxious to obtain live specimens of Fowl Tick (*Argus americanus*) from Australia. He has proved that they transmit an organism, *Spirulosa*, into the blood of their host, which is the cause of the mortality among tick-infested fowls. He has also discovered, that leeches can transmit the organism *Trypanosoma* into the blood of fishes and frogs, and that though it does not affect the fish, yet frogs from Algeria, into which it had been injected, died within fifteen days.

At the College of France we met Dr. L. Felix Hennegay, who is one of the greatest authorities on the morphology of insects, and has published some fine works on the anatomy of insects.

On the 13th of March I left Paris for Madrid, reaching the latter place on the following afternoon, and obtained the services of an interpreter the same evening. Next morning I went down to the Department of Agriculture, and found that the Minister would not be in his office till midday on the coming Wednesday; so, after making an appointment to meet him, I went round to the laboratories of the Museo di Ciencia Naturales, and met Signors Lauffer and Mercet, in the absence of Dr. Bolivar. They at once opened out all their cabinets, which are fitted, not with wooden drawers, but with stiff cardboard, glass-topped boxes that fit closely into the cabinets. Though there were no special economic specimens, there is a very complete collection of the Spanish insect fauna dealing with all the orders, and also a general collection. Among the economic specimens are several named species of beetles of the genus *Lyctus*, to which our "rattan furniture" beetle belongs. Among the Coccinellidæ I observed a specimen labelled *Novius cruentatus* Berlese, which appears to be a variety of our very variable species *Novius cardinalis*.

On the following morning I met Dr. Bolivar, the Director of the Museum, who explained that the museum collections were not on an economic basis, but now that people were taking an interest in economic entomology they were making an agricultural collection.

Dr. Bolivar is one of the leading authorities on Orthoptera, grasshoppers and locusts, and has an immense private collection. Two of the common plague locusts of Spain are *Stauronotus genei* and *Arcyptera flavicosta*; the latter is the large red-legged locust. Both of these do considerable damage to the grass and crops. From the Museum I went out to the School of

Photo. by I. Lacoste.

Ministerio de Fomento, Madrid, Spain. The Department of Agriculture.

Agriculture, where the Department has a large area of ground laid out in experimental plots: and at the college about 200 students from all parts of Spain are taught scientific and practical agriculture. Professor Navarro, who is the general scientific adviser, and has charge of the various experiment farms and stations, informed me that at the present time there was no law in force in Spain to deal with insect or fungus pests, but there was a draft before the House, which the Department expected to get passed into law this year, when they would be able to deal with pests coming into the country and those that were there already. He showed me his fine collection of insect and fungus pests, and said that the chief industries, as far as orchards were concerned, were the growing of citrus fruits and olives. Of the former an immense quantity are shipped to London. The worst diseases of the orange are the three scale insects *Lecanium hesperidum*, *Aonidia auranti* (our red scale), and *Mytalaspis flavescens*; and sometimes a little *Aspidiotus lemonii* comes on the fruit. The two worst fungus diseases are *Capnodium citri* and *Gomosis del Navanj*, the latter a form of "collar rot."

The Department are afraid to do any fumigation of the trees for scale, "for fear the orchardists might poison themselves," but many growers spray or wash their trees, chiefly with oil mixtures. The bulk of the citrus trees are grown not from seedlings, but cuttings placed in the ground till they are rooted, and may or may not be afterwards budded or grafted. The orange growers cover a large area in the south of Spain, but the individual holdings are small, so that every tree can be looked after. Apples are only grown in the north of Spain, chiefly along the coast, and there is no export of apples; a great quantity, and all the damaged or wormy ones, are made into cider. Professor Navarro says that codling moth is the common pest of the apple there, and a very large percentage of the crop is always infested. He had never seen or heard of any parasite being any check on codling moth in Spain. One of the pests that was much in evidence was a small chrysomalid beetle (*Cassida vittata*), which is so abundant in the sugar-beet fields feeding upon the plants; it has caused a great loss to the growers.

He strongly advised me to visit Valencia, the centre of the citrus industry, so on the following day I called on the Minister for Agriculture, who gave me letters to the Director of the Experiment Station (Escuela Practica de Agricultura), at Burjasot, Valencia.

On the 20th March I left Madrid for Valencia *via* Barcelona, and on the following day was travelling southward. At Tarragena there is a large alluvial plain running in from the coast, which is well watered by irrigation from the hills behind. Here there is a great extent of mixed orchard; but, as one gets further south, the poor ground running back to the barren hills is clothed with olive trees that seem to be able to grow without any actual soil so long as they can get their roots into the broken limestone. Lower down come vineyards, but the richer land between the sea and the mountains forms, in many places, long unbroken stretches of citrus orchards, until one comes quite close to Valencia, where, in the immediate vicinity, there are a great number of fields of vegetables. The rich black soil is ridged round with raised irrigation channels, from which the water is run over the fields. In the vineyards and orchards nearer Barcelona the country is covered with shallow wells, where the water is drawn up with earthenware jars attached to a band and wheel.

At the Experiment Station, some distance from the town, I found the Director, Dr. Marti, who took me all over the fields and orchards. The citrus crop was being gathered, and along the line and around the railway

stations there were great quantities of waste oranges scattered about. Dr. Marti said that there was seldom any trouble from the fruit-fly (*Ceratitis hispanica*), now considered identical with *C. capitata*; but at Malaga, further south, towards the end of the year, this fruit-fly often did a great deal of damage to the citrus crop. No methods are used to deal with it, except that some of the growers clear up their orchards and destroy the fallen, useless fruit. The Olive Fly (*Dacus oleæ*) is a well-known pest all through Spain, wherever the olive is cultivated, but apparently does not do anything like the damage that it causes in Italy. The orange-trees are planted deep in the soil, and, in consequence, suffer much from "collar rot." To rectify this at the station all the main roots round the trunk were exposed and the soil thrown out. All the trees here were grafted. Red scale is the commonest scale insect in the citrus orchards.

From Valencia I returned to Barcelona, going straight on to Montpellier, in France, where I spent two days with Dr. Valery Mayét, and at the Ecole de Agriculture. The Director was away in Paris, but the Secretary placed an officer at my disposal, who took me all through the laboratories, herbarium, and afterwards over the fields and experimental plots. The study of viticulture is the important work of this school; and in the insect and botanical laboratories all the insect and fungus diseases of the vine are exhibited; while in the hot-houses there are living forms; and in the experimental plots all the different methods of pruning, cultivating, and trellising vines are shown. Some experiments in the German method of "paving" are also being carried out. The ground, in which a number of growing vines are planted, is covered with different coloured basic slag mixed with a little concrete or cement. The effect of the sun's rays on the different coloured ground is being noted in the rapidity of the growth of the vines and the ripening of the berries. Some other plots were covered with paving stones among which the vines grew; others were growing under cover of river gravel of different quality and thickness.

The preservation of ripe grapes was pointed out to me by the Secretary. Each bunch is cut off the vine with a section of the cane; this is placed in a jar of water and charcoal; each jar is then hung upon a hook driven into the wall, so that each bunch hangs down without touching anything. If the store-room has a regular temperature, these bunches are said to keep for months, and though the stalks wither the berries remain firm and hard.

From Montpellier I went on to Marseilles, where I took my passage to Naples in the Nord Deutscher Lloyd steamer, reaching Italy on 27th March. At Naples I engaged a guide and went out to the entomological laboratories of the Department of Agriculture at Portici. Here I met Professor F. Silvestri and his staff, and went through their collections. Many of the cosmopolitan pests are common in Italy. Professor Silvestri is the exponent of the value of parasites, and hopes to deal with the Olive Fruit-fly (*Dacus oleæ*) in this manner. This fly is one of the worst insect pests in the world, and all the Italian entomologists are working to destroy this very serious pest to the great olive industry.

Here I learnt that the damage caused by the Mediteranean Fruit Fly was confined chiefly to Sicily and to Calabria on the mainland. The Department recommend the burning and boiling of all infested fruit, but they have no power to enforce their recommendations.

Professor Silvestri suggested the idea that fruit-flies could be made an international matter. All countries that are infested with fruit-flies could pay a certain sum, to be used in original investigations by a board or staff of entomologists for the benefit of all the countries interested in the matter.

[*Photo. by A. Stauda, Vienna.*

The K. K. Hof-Museum, Vienna, Austria.
This is the Natural History Museum, situated in Maria Theresa Square. It faces the statue of the Queen.

Finding that there was a regular mailboat service to Palermo, Sicily, every evening, with letters to Dr. Perez, in charge of the entomological work in Sicily and Curator of the University Museum, I reached Palermo early on Sunday morning, and spent the day with Dr. Perez among the citrus orchards a few miles outside the town. Most of these orchards are enclosed in high stone walls, and are regular thickets of trees which are all standarded, having no branches up to 4 or 5 feet from the ground, and often much higher; planted at all sorts of angles they form a regular thicket above one's head. The trees are all grafted or budded about 3 or 4 feet above the ground on the stem of a wild orange. It is said by the orchardists that trees grafted in this manner are not subject to collar rot. Very little attention is paid to pruning, and most of the trees are said to be from sixty to seventy years of age; they are planted from 9 to 12 feet apart.

Returning to Naples I left for Rome the following day, and then met Professor Grassi, one of the leading authorities on insect anatomy in Europe, and well known for his work in connection with mosquitoes and malarial fever. He showed me many interesting specimens upon which he was working; among them the life history of a blood-sucking fly, allied to our sandfly (*Phlebotomus papatasi*), which he had bred in the solid sediment of the city sewers. In old times these flies were such a serious pest and so numerous that it was impossible to live in some districts. He has also done a great deal of work on termites and their internal parasites.

With regard to the leaf-galls of phylloxera, which I was told in Montpellier were rare in France, Professor Grassi says that they are quite common both in France and Italy on the lowest leaves of American vines growing in damp ground at some seasons of the year. Among some interesting specimens he gave me was a fresh-water crustacean (*Apus*, sp.), which is said to be so numerous in some parts of Lombardy that it cuts off quantities of young rice growing in the water. The waters of our western swamps teem with a closely allied *Apus*, which might, under such conditions, become a pest, though at present it is a source of food to our wild ducks.

The Agricultural Museum was afterwards visited. It contains a large exhibit of both agricultural and technical specimens. Here also was displayed a fine collection of the insectivorous birds of Italy, though they have no protection of birds in Italy, and not only kill all their own native birds and eat them, but erect traps all along the sea-coast to capture the great flocks of migrating birds crossing from Africa to Europe.

At Florence I found that Professor Berlese had left that morning for Genoa, but met the assistants at the Entomological Branch, and was shown over the different divisions by Drs. Guercio and Paoli. With them I went into the spraying of olive fruit-fly and other mechanical methods, which are given in detail later on. Besides the olive fly they have several destructive scale insects, one of which, *Diaspis pentagona*, is very prevalent upon mulberry trees; if neglected it often kills them. As the mulberry is very extensively grown in northern Italy for feeding silkworms, anything that interferes with the output of silk is a serious matter. *Lecanium oleæ* is common, but more a pest in gardens and small plantations. Wiring to Dr. Berlese to wait for me at Genoa, I left the following afternoon and met him in the evening, when we talked over his methods till late in the night. Here I visited my valued correspondent, Dr. Gestro, Curator of the Museum; We compared notes on New Guinea insects, and I saw some of the entomological collections. Then I went to the University of Genoa, and with Dr. Ricca examined the herbarium and large series of hot-houses and collections of plants belonging to the School of Botany.

From Genoa I went direct to Vienna, which was reached on the 9th of April, and where I spent three days, divided between the Natural History Museum and the different branches of the Department of Agriculture. The museum contains many very important economic collections, among which are Signoret's classical collection of *Coccidæ*, and a very large collection of Diptera, containing many of the types from Meigen, Schiner, Loew, and Mik's collection. Here I obtained a great deal of valuable information as to the identification and range of the different species of fruit-flies recorded in the supplement of this report. Among some interesting groups are Loew's collection of *Gasterophilus*, and other stock infesting flies; quite a number of bot-flies are common in Austria, and the curious Elephant Bot (*Cobboldia elephantis*) has been bred from the bots of an elephant in the Vienna Zoological Gardens. There are a number of Australian coccids in Signoret's collection, and the types of many curious species; also a very curious coccid, *Tachardia or Lecanium*, which is unnamed, is labelled Brisbane, Queensland; it is as thick as one's little finger, and is on an acacia twig. Under the genus *Spondylaspis*, which, though a Psyllid, Signoret, from the scanty material in his hands, believed to be a scale insect, is represented by several specimens, with MS. names that were never published:—*Spondylaspis bancrofti*, identical with my species; *Cardiaspis plicatuloides*; *S. cereus*, an undetermined species of *Cardiaspis*; and *S. spinulosa*, which is *Cardiaspis artifex*, described by Swartz from Australia.

Dr. A. Handlirsch showed me over the different departments, where the specimens are very beautifully arranged, and I then went through the Lepidoptera with Professor Rebel, who, besides being custodian of this group, is lecturer on entomology to the students of the Agricultural College. Among some of the most injurious moths in Austria are those that attack the foliage of the forest pine trees. *Conchylis ambiguilla* is a moth whose larvæ in the first brood eat the flowers of the vine, and in the second generation later on damage the immature grapes. *Eurycreon sticticalis* is very destructive to the foliage of the sugar beet.

At the laboratories of the Agricultural Department, where all the different branches are housed, I met the chief of the staff, Dr. F. Dafert, who passed me on to the Chemical Laboratory, where they deal with plant-manures and soils. A charge of 5 krones (4s. 2d.) is charged to farmers for each analysis of soils. At the dairy branch they have charge of the testing of all the samples of milk supplied from the city milk shops, which are sampled every month. The supervision of the dairies from which the milk is sent is under the Veterinary Department, who also test the cattle foods. The Viticultural Chemist has tests made of all wine sold in the city markets, and the department can prosecute all selling such below standard.

The Turf or Peat Branch shows the value and uses to which the large deposits of peat in Austria can be put besides fuel; much of it is used in distilling alcohol, also for bedding for stock. Models of peat stacks and tools for cutting and digging peat are exhibited.

The Fisheries Branch is another important branch, as much work is done in protecting the abundant supply of fresh-water fish; and at the Agricultural exhibition at the suburb of St. Marx, there were over 300 tanks of live fish, in many cases showing the development and different stages of their growth. The diseases and food of fishes is also attended to by this branch.

Dr. Arthur Bretschneider has charge of the laboratories dealing with bacterial and fungus diseases. A number of rabbits were being fed in one room upon American maize that had caused a peculiar disease among the people eating it, and which was supposed to have been contaminated by mice.

Drs. Wahal and Fulmer have charge of economic entomology, and have cabinet collections of injurious insects. Among the leaf-eating moth larvæ they consider *Liparis monacha* one of the worst upon fruit-trees. Two white moths, *Euprotis drysasholis* and *Aparia cretugi*, make webs in the apple trees and do considerable damage. The larva of a geometer moth (*Cheimatulis hamata*) is another apple pest; a lime ring is used round the tree trunks to keep the caterpillars from ascending the tree. A small weevil (*Anthonomus sulcicollis*), and a second species, *A. punctipennis*, do a great deal of harm to sugar beet. The larvæ of the Gall Fly (*Cecidomyia pisavora*) live in the eyes of the young pears, and cause them to swell and drop off; it is a serious pest at times.

The rabbit is a great favourite in Austria, and at Easter the shops were full of toy rabbits and little chickens full of sweetmeats, while the large Easter eggs were often sold containing a little live rabbit, "little children of the fields." At the St. Marx show there were hundreds of different varieties of domesticated rabbits and Belgian hares, some of immense size. In all, there were 600 cages of rabbits, and the prize specimens were weighed, measured, and handled like prize poultry.

I left Vienna on the 12th April, and reached Budapest, the capital of Hungary, the same evening. At the Royal Museum of Hungary I met the Director, Dr. Horvath, who introduced me to his staff, and with them I examined many of the most important groups in the entomological cabinets. This museum is famous for its extensive collection of Hemiptera (plant bugs, &c.), and of which Dr. Horvath is a well-known specialist; and Diptera (flies), of which Professor Kertesz is a leading authority. I made many notes on the groups containing fruit flies, among which are some unique specimens collected by Biro in New Guinea and the Malay Archipelago. He also showed me the mass of references and cards used by him in compiling his great catalogue of the Flies (*Catalogus Dipterorium*, 1902-8).

Then I visited the Central Bureau of Ornithology, a branch of the Department of Agriculture, in charge of Dr. Otto Hermann. For this work the kingdom of Hungary is divided into nine districts according to their altitude. The migrations of the different species are observed and noted; the stomachs of great numbers have been dissected, and their food tabulated to show their food habits, and thus their economic value as insectivorous birds is demonstrated. The foresters are all interested in the work, and artificial nests are made and distributed all over the forests and islands in the Danube for their protection. Many interesting pamphlets are issued by this branch, some of which are written in English.

The Royal Hungarian Agricultural Museum is certainly one of the most complete agricultural museums in the world. "The object and aim of this museum consists of bringing before the eyes of our agriculturists, landowners, proprietors of forests, horticulturists, and owners of vineyards, in a collective exhibition, such products and articles as may be considered essential and important from an agricultural point of view, and capable of conveying a reliable and practical knowledge to Hungarian as well as foreign industrial men, tradesmen, consumers, merchants, and all those interested in agricultural products."

This museum was founded in 1896, and in 1900 2,400,000 crowns were given by the Government to build the present museum, which was finished last year. In the wheat-hall there is a collection of samples of wheat from fifty-three different parts of Hungary for ten successive years. These, with the soils in which they grow, have been analysed by the National Chemical Institution, and the results exhibited with the samples. With this there is

also a general collection of Hungarian and foreign wheat. Then come samples of seeds, vegetables, fodder, maize, and medicinal herbs, with the methods for preserving fodder, tests of hay, &c. Tobacco is shown from the experimental station at Debreczen, and samples of all kinds of tobaccos. In the horticultural division, models are made of all the different kinds of fruits; samples of jams and preserves from the leading factories are exhibited. The pests, both insects and fungus, are illustrated, and a series of the nests, eggs, and birds that are considered valuable to the landowner are mounted. Then come the noxious and useful animals of agriculture, and further on models of all the different types of Hungarian stock—sheep, pigs, horses, and cattle. Another room is devoted to the different implements and dresses of the forester, herder, farmer, and fisherman. A very fine collection of paintings of the different kinds of grapes is shown; implements used in the vineyards, wine-presses, &c. All dairy products are exhibited; honey, with models of hives. Sugar, beer, and other products are placed in cases. Agricultural machinery, agricultural architecture, and a collection of drawings and pictures illustrating the growth and history of agriculture in Hungary is shown. The home industries—hand-made baskets, weaving of flax and hemp, and tools—form another court, with a complete illustration of the silk industry of Japan. The upper portion of the building is devoted to forestry, one corner being built up in imitation of a forest, with groups of the birds and animals found in the forest. Specimens of all the different timbers, the implements, and guns used by the foresters, are there.

All through this beautiful building there are pictures, drawings, plans, and maps, illustrating the different subjects. These were explained to me by the Assistant Curator, Dr. Paikert. This museum might well be copied in Australia; and if all the primitive implements used by our early settlers and stockmen could only be collected before they are lost for ever, they would make a very interesting exhibit. Though the implements of our natives are not numerous, they could be exhibited in an attractive manner in an agricultural museum, and be of great interest. With Dr. Horvath I called upon the Minister for Agriculture, Dr. Ignatius Daranyi, and in his absence explained my mission to his Under Secretary. From there went over to the laboratories of the Agricultural College, where there is also a small teaching staff, for the purpose of giving a last year's course to the head student of each of the country agricultural colleges—about ten in number. These buildings are only just finished, and form a fine block of buildings, surrounded with small experimental gardens. The Director, Mr. J. Jablonowsky, who is also the entomologist, showed me all their insect pests; and he has a very fine collection of pests, and timbers, &c., damaged by them. Besides the Hessian Fly, the wheat crops have a very serious pest in the larvæ of a lamellicorn beetle (*Zabrus gibbus*), which in the grub state devour the rootlets of the crop, while the perfect beetles hatch out, and, climbing up the stalks, damage the ears. In a bad attack they sometimes take 50 per cent. of the crops. The Stem Saw-fly (*Cephus pygmæus*) also does a considerable amount of damage to the stems of growing wheat. The locust plagues are often a very serious item on the great plains of southern Hungary, destroying so much grass and crops that the different district officials, aided by the Central Government, have instituted a regular crusade against them. The Agricultural Department have 300 machines in use. This machine is after the fashion of a reaping machine, and is drawn by horses and fitted with stiff brushes, that sweep up and destroy the small locusts before they can fly. These machines are sent down to the local authorities in infested districts, and a number driven in line soon sweep over a large area. Quite a

number of different beetle-larvæ attack the roots of the vines, particularly in the light sandy soils in which most of the vineyards are now planted since phylloxera has appeared. Codling moth, as in other parts of the world, is one of the worst orchard pests in Hungary.

Dr. Balint showed me over the viticultural laboratories, in which they have a very fine series of plant diseases, particularly of the vine. These are preserved in a saturate solution of sulphuric acid; the jars are sealed up, and thus the colours remain fixed. Among these were some very fine examples of the leaf-galls of phylloxera. Another method of exhibiting diseased foliage was to place the leaf between two sheets of clear glass in glycerine jelly, which were then placed in frames in the windows. He showed me experiments in testing the soil by the different weeds growing upon the poor, sandy soils, in which phylloxera could not exist. With an accurate knowledge of the plants growing in these soils, he said, they could say whether it was safe or not to plant vines in that particular land. Subsequently I paid a visit to the Nyiregyhaza district, and, through the kindness of Dr. Kallay, was able to go over the vineyards near the famous Tokay district, where the land consists of very light sandy soil. The vines are planted 3 feet apart, and the rows are about the same distance, so that it is all hand cultivation. The vines are covered over with sand in winter. I was told that in this district, though most of the large vineyards were planted with resistant stocks, many of the smaller men use the old vines, trusting to the light sandy soil. All the small growers either sell the grapes to the wine-makers at so much per ton, or crush the grapes and sell the must to the dealers who come round.

The Government wine-cellars at Fincemesteri are formed of great galleries and chambers hewn out of the side of the mountain of limestone, and consist of two main galleries and seven cross galleries. The vintage of the Government vineyards, which are very extensive, is treated here, and they usually have from 7,000 to 8,000 hectolitres of wine on hand. They hold auction sales four times a year, to sell off the surplus stock. Here they also have a small class of ten to twelve students, who go through a three years' course of wine-making and cellarman's work.

At the School of Horticulture is another fine institution which has a regular teaching staff, dealing with general horticulture and orchard work, and on an average there are ten students at work. There is a large flower-garden, an experimental vineyard, and 12 acres of orchard, where things are both grown in the open and under glass. The Director said that the most popular keeping apple was the "White Colville."

At the city markets I saw a very fine collection of fruit and vegetables; and in some pens behind were a number of the white, curly-haired pigs peculiar to this country, which, when seen in mobs herded in the fields at any distance, might be easily mistaken for sheep. Most of the fish are kept in large tanks, the seller dipping them out with a net, so that the buyer gets them alive. Among the dead fish were some large sturgeon, common in the waters of the Danube.

At midnight on the 21st of April I left Budapest for Constantinople, on my road to Cyprus. Passing over the great plains of Servia and Bulgaria, dotted over with flocks and herds, and over much rich farming land, I reached the Turkish frontier at midnight of the second day, and arrived at Constantinople about 10 o'clock the following morning.

Here I did not expect to gain much information in regard to pests or agriculture, but through the kindness of the British Consul, Mr. A. F. Waugh, I was enabled to get into touch with some of the Government

officials and persons interested, and obtained some very interesting notes. Through Dr. Maclean I was invited out to Mr. Thompson's estate at Bostondjok, on the Asia Minor side, and saw the Turks pruning and grafting their vines, and digging the vineyards with great two-pronged forks. At one time there was quite a large wine industry here; but the massacres of the Armenians and the subsequent damage by earthquake to the property of the remaining merchants, who were the chief consumers of wine, has so reduced the sale that nearly all the vignerons have given up making wine and grow table grapes instead. They have a very fine thin-skinned variety which always brings a good price. Phylloxera swept all over this country many years ago, and a great number of the orchards died out. Mr. Thompson's has been replanted with blight-resistant stocks, but very few of the Turkish growers have changed their methods, and still graft on the wild grape. Curious little watch towers are built up in all the vineyards, where a man sits and guards the field while the grapes are ripening.

With a letter from the Consul, I called at the Dette Publique Ottomane and met M. Raymond, one of the Inspectors in the department, who furnished me with a great deal of information regarding the agricultural industries of Turkey. He endorsed the opinion of Mr. Thompson that the wine industry had been destroyed, but said it was mainly due to the ravages of phylloxera. The Smyrna raisin industry is an important source of revenue; the bunches of grapes are dipped in a mixture of oil and potash and then placed on the ground to dry. Where the growers are too poor to buy potash, they make a lye from the ashes of the burnt vine cuttings. The raisin grape vines are cultivated somewhat differently from the table and wine grapes, being planted 2½ metres apart in rich black soil, and allowed to spread all over the ground until the grapes are formed, when they are tied up to small stakes so that the bunches which grow along the canes hang clear above the ground. Fungus diseases are very prevalent in all the vineyards; and they say that a very bad form of mildew, that was practically unknown in Turkey until a few years ago, has done more damage, and is more difficult to treat, than all the other pests put together. The silk industry is also in the hands of the Dette Publique Ottomane, and is fostered in all ways by this department. They examine all the eggs, and supply cuttings and young mulberry plants free to all the growers that apply, and most of the silk grown in Turkey is reeled and manufactured in the country. Last year the quantity of cocoons grown in Turkey in Europe reached to 3,623,145 kilos, a kilo being equal to 2 lb. 8 oz.

This department encourages orchard work, and collects all the revenue from the silk, wine raisin industries, forestry, licenses, fisheries; and has also the monopoly of the salt industry. The chief fish in the markets is a large flat fish commonly known as a "turbot," and a small, slender, silvery green fish known as the "mackerel"; the latter are caught in immense numbers in the Bosphorus. They are gutted, soaked in salt water for two or three days, and then hung over strings and dried in the sun, and are an important item in the food supply of the poorer classes. I paid several visits to the fruit markets, where an immense number of oranges are sold, coming in from all parts of the Mediterranean; most of the other fruits are poor, and very few bananas appear to come into Constantinople. Apples are not grown in any quantity in Turkey, and at this season of the year are very poor, both in quality and size. The best apples come from the neighbourhood of the town of Amasia, on the Asiatic side. The market for dried fruits is very extensive, and all kinds of curious dried fruits, beans, pulse, and grains of all kinds can be found upon the market stalls.

Scale insects do not appear to do much damage, for all the fruit was remarkably clean; in a very few instances only were scales noticed upon the fruit.

On the 30th April I left Constantinople for Cyprus *vid* Smyrna and Beyrout, reaching my destination on the 6th of May. A day was spent in Smyrna where the markets were visited, and we stayed two days at Beyrout. The latter is an important centre of the silk industry, and for miles beyond the town the fields are nearly all planted with mulberry trees, and there were many reeling machines and hand-looms working in the houses in the outskirts of the town. There were large mat-covered houses in the centre of many of the fields where they were evidently feeding the silkworms, but without a guide it was not advisable to trespass too far into their fields. One of the things that struck me much at all these ports was the slaughter of all the small birds in the fields; every Turk I met had a gun, and shot at every bird that moved; while in the markets there were scores of dealers selling strings of birds—from swallows to dollar birds.

Reaching Larnica early in the morning, my arrangements were much simplified by the kindness of Mr. Clement Reid, of the Geological Survey Department of London, who was visiting Cyprus on official business, and had a carriage to take us on at once to Nicosia, the capital, 25 miles inland. The country between Larnica and Nicosia is the worst part of the island, being destitute of anything but little prickly shrubs, and consists of limestone and marl hills forming low undulating country. At Nicosia the country improves, and beyond the town there is a considerable amount of cultivation. My first business was with the Director of Agriculture, Mr. Saracomenos, and we made an appointment for the following day to see the locust hunters and their camp.

Though I have given some account of the methods adopted, in my Progress Report upon the methods used in dealing with the locust plague in Cyprus since the British occupation of the island in 1879, the question of our locust or grasshopper plagues is such an important one that I propose to repeat my previous information. At the time when the British Government took over the island of Cyprus from the Turkish Government, agreeing to administer the country under mixed tribunals, and paying a sum of £90,000 per annum for the value of the revenue obtained in taxes from the island, the hordes of locusts that bred in the barren lands usually ate about half the crops, and occasionally all of them. The destruction of these pests was one of the first problems that the authorities had to take in hand if they were going to get any revenue to pay the Turkish Government.

Through the kindness of Mr. A K. Bovill, Chief of the Forestry Department, I obtained a complete set of the Commissioners' reports, from the time when they first commenced active field operations against the locusts in 1880.

In the 1880–1 report, by Commissioner Inglis, Famagusta, all able-bodied men in the district of Nicosia, and throughout the infested districts, were assessed to furnish 7 okes of locust eggs before the 1st of October, after which date they had to furnish 8 okes; and in the district of Nicosia 80 per cent. of the people collected this quantity. The collection of the eggs commenced at the end of June, and within six months 138,422 okes of eggs had been gathered; as every pod (or egg-cluster) contained from 30 to 35 eggs, and each oke contained from 450 to 500, this represented a total of two thousand million locusts.

In March, 1881, however, in spite of all this destruction, the locusts appeared just as bad as ever, and it was decided to try Mattei's plan of screens and pits; this was so successful that it was continued every year until 1897,

when the pest was practically under control. In 1881 there were 372 screens used, each about 50 yards in length, with 491 traps constructed along the line. Each mudir (district officer) was made responsible for his district, and had under him a number of first and second-class assistants.

The screens were set up at right angles to the line of march of the hoppers, and pits were dug at intervals of 30 to 50 yards; a strip of oilcloth was sewn along the top of each screen, over which an assistant regularly rubbed an oiled cloth so that none of the hoppers that climbed up the screen were able to get beyond the lower edge of the oilcloth. For the first four weeks, while the locusts were small, 2,600 pits were dug to a depth of 2 feet, and filled with trapped locusts. Then when they started to fly, a price of 30 paras, afterwards increased to 60, was offered for every oke of winged locusts, and it was found that they were very easily captured in the evening and early morning.

In 1883 there were 7,543 screens in use in the four districts, and 2,631 labourers were engaged in the work. It was estimated that over 259,284 millions of locusts were destroyed in this season's campaign, at a cost of £12,333.

In 1884 the number of screens was increased to 11,085, and the money expended reached to £14,746. The Commissioner, commenting on this expenditure, stated that up to this date (1886) the sum of £66,841 had been spent in the work of locust destruction. He wrote:—

"Large as this expenditure may seem, it is certain that it has already been recovered by the island many times over, in the value of the crops saved. Assuming that only a quarter of the wheat and cotton, and a sixth of the barley and oats, would have been destroyed, had no vigorous means been taken to destroy the locusts, the loss in the island would have amounted to £80,000. These figures are derived from the estimated value of the crops based on the assessment of the tithes of the years 1882–83–84."

These methods were carried on for some years longer, and in 1897 the expenditure was £4,216. The area of the island is 3,584 square miles, and the locusts laid their eggs chiefly in the barren patches on the plains. The locust-catchers, who are paid by results, were busy at work sweeping the barren hills a few miles outside Nicosia. They were armed with a stout calico net, shaped at the mouth like a bow, with a handle across the middle; the flat side was swept over the rocks and low herbage, and the locusts fell into the contracted bag-shaped extremity, from which they were shaken by the hunter into a receiving bag carried at his belt. There were a number of men at this work, who, when their bags were full, walked back to the town, where, outside the gates, the Government had a locust camp. Here was an office under a tent; an attendant, after shaking the dust and dirt out through a sieve, weighed the accumulated locusts, entered the weight in his book, and the officer in charge issued a slip for the value at the current rate, which the hunter presented to the Treasury and was paid the amount it represented. After the day's collections are gathered together in a large sack, they are emptied into a covered pit into which a quantity of lime is thrown. The residue, at the end of the season, is used for manure in the experimental garden.

The Director informed me that during the last few years in Greece they have had very good results from spraying the locusts in the hopping stage with caustic soda and oil, and that the locust officers in Cyprus were going to try it next season.

There are three species of locusts common in the island, of which the plague locust (*Stacronotes crucitatus*, var. *americanus*) is the most harmful. The eggs hatch out in March, and in ordinary seasons the locusts are hunted well into May.

[*Photo. by J. F. Foscolo, Limassol.*

Typical View of the Marl and Chalk Formation between Larnica and Nicosia, Cyprus

The locust tax, to provide money for the destruction of locusts, is levied,—first, upon all tithable produce, 1 per cent. on the value (besides the ordinary tithe); secondly, on all houses, shops, and other buildings, 1 per 1,000 on the estimated value yearly; thirdly, on every annuity, pension, or stipend payable out of the public revenue of the island yearly, 1 per cent. on all incomes amounting to £200; fourthly, on every sheep and goat yearly 15 paras. So that everybody on the island has to contribute something to the fund.

The increased area under cultivation since the settled government of Britain has probably also been a great factor in helping to destroy the locusts, for they are driven on to the barren lands more every season, and are more easily dealt with.

With the Director I went through his collection of the chief insect pests, and found that "Red Scale" (*Aspidiotes aurantii*), so common in Australia, is not only the worst pest on the citrus trees, particularly at Famagusta, where a great many orange trees have been killed by this scale, but I also found it upon the foliage of the wattles, growing round the town. Among the curious insects Mr. Saracomenas showed me were some wingless Mutillidæ (females of an undetermined species). These are known as "Sflangi" to the natives, who are very frightened of them, and say that their sting will bring on "Sflangi face," a form of blood-poisoning which frequently causes death. These wingless wasps are very common in the summer, crawling about on the ground, and can sting very sharply if touched. I learnt afterwards from one of the medical officers how this idea of the deadly power of this little wasp originated. The natives often sleep upon the freshly-flayed sheep and goat skins, and as sheep-pock is a very common disease in the flocks, they thus frequently contract this disease, which forms virulent pustules (Sflangi face). The little stinging wasps often crawl on to these skins and sting the sleeper if crushed, so that the severe sting becomes associated with the disease, and all the Cypriots are firmly convinced that the disease is caused by the wasp.

The Athalassa Experiment Farm is primarily run for the improvement of the live stock on the island, and they have imported Durham and Galloway bulls, but the latter do not thrive. Their Jack donkeys are almost black, and throw very fine stock, the Cyprus mule being a very fine serviceable animal.

The sheep are large, leggy beasts, with black heads, bare legs, and large drooping ears, and have curious fat tails terminating in a corkscrew-like extremity. In most of the native flocks the black ones predominate, and at the farm they find it very difficult to breed out the black strain. The wool does not average more than 6d. per lb., and is very light and coarse in texture. Sheep are very dear for mutton, and often bring £1 per head. There are about 250,000 sheep upon the island, all in little flocks, and about the same number of goats, and most of them run together, herded by the children, as there are no fences anywhere.

The Department of Forestry and Mr. T. K. Bovill have done a great deal of work in reclaiming and planting the waste land; they have had wonderful results in establishing several species of scrubby Australian wattles upon chalk and marl hills on which there is apparently no actual soil. All round the capital, Nicosia, there are belts of Australian gum trees, wattles, and casuarinas, which grow very well. Though it is probable that all the level country of Cyprus was in ancient times covered with some sort of tree, the native forests of oak and pine only exist on the mountain slopes now. The question of fuel is a very important one in many parts of the east, and

particularly so in Cyprus, so that when the trees are fully grown they will be regularly thinned out, and it is expected that the timber will yield enough to pay all expenses.

I spent five days accompanied by Mr. Beven, of the Agricultural Department, in travelling round the rural districts. After leaving Nicosia for Limasol, the road runs through a considerable amount of poor country similar to the marl and chalk between Larnica and the capital, and then through fields of barley and afterwards plantations of olive and carob trees. Both of these latter produce valuable crops, but much of the country where olives will grow is also suitable for grapes, and as the vine is the most profitable, the Cypriots do not grow enough olives to supply their own wants, and a considerable amount of olive oil is imported. Some of the olive trees must have attained the age of some of the famous groves in Spain, which were planted by the Moors 500 years ago, for in many places the centres of the original trees had decayed long ago, and at each angle a more vigorous portion had formed a fresh vigorous stem, so that instead of the old tree it formed a bunch of three or four trees, all covered with flowers in evidence of a good crop. In returning to the hardy habits of the olive tree, a gentleman in Constantinople told me that during the last riots in Crete, the natives in many places burnt out each other's olive plantations, leaving them apparently ruined, so much so that the English people made up a fund to replant the orchards, but in the following year, after good rains, the trees all burst out into leaf again, and gave the most bountiful crop of olives that had been seen for many years, the year's rest from cropping after the fire probably being the reason for the great crop

The Carob Bean tree (*Ceratonia siliqua*), which is a native of the Levant, grows wild in Cyprus, but all the best trees have been grafted. It flowers in August and September, and the crop of beans is gathered in the following August. It takes its popular name "caroub" or "carob" from the fancied resemblance of the broad flat bean to a goat's horn. Like the olive, it grows upon very poor soil without irrigation, and the cultivated trees bear a large crop of broad flat beans containing from ten to eighteen flat seeds. When ripe the beans have a very pleasant sweet flavour, and are used for making sweetmeats; but the bulk of the beans are sent abroad to be ground up and made into cattle food. These trees grow very well in the dry parts of Australia; and in the time to come, when much of the arid west will be planted with edible scrub plants and trees, it is to be hoped that the handsome carob tree will be among those utilised, and its crop of beans used to feed our stock. In 1906 there were 44,965 tons of carob beans shipped from Cyprus, valued at over £157,000. Every little corner along the road where there was any soil was planted with barley, even if it were only a few yards in extent. After passing a large wattle plantation, which was set out to keep the drifting sand from blocking up the roads, Limasol was reached the first night; this is the chief port for carob bean and wine shipments. The next day was spent among the mountains among the vineyards which are planted in all kinds of angles, on the sides of mountains and on the edges of precipices, where one would hardly think even a goat could climb. The native wine is of poor quality on account of the primitive methods used in its production; it is usually cleared with gypsum and carried down the mountains in pigskins on pack saddles, and then sold to the wine merchants of Limasol, who ship the greater part to Egypt. An English company is making wine at the village of Perapidha, and, under improved conditions of manufacture, are sending a quantity to England and Germany.

Oïdium is very prevalent all through these orchards, but growers are only just beginning to understand the value of sulphur, which is imported by the Government and distributed at a very low rate to the vine-growers. Phylloxera is unknown in Cyprus, probably because soon after the occupation the Government made a very strict regulation against the importation of any plants into the island from abroad. Coming over the mountains, numerous orchards were visited in the great Athalassa Valley; on the upper slopes were cherry, apple, and mulberry trees, but when we reached the plains we came to the Turkish village of Lefka, where there are quite a number of oranges grown, some under irrigation, but they are planted in all sorts of irregular thickets and are, as a rule, very badly kept. Many oranges were lying about under the trees, but on examination all of them had a hole gnawed in the side and had been neatly cleaned out, leaving only the skin; the owner told me this was done by the bush rats. This rat may be a very effective agent in checking the fruit-fly, which, as far as I could learn, was unknown on this side of the island.

Before leaving Cyprus, I spent a day at Famagusta, where, through the kindness of Commissioner Travers, who sent one of his officers with me, I saw a number of the best citrus orchards in Cyprus. This was the district in which Mr. Saracomenos had told me the Mediterranean Fruit Fly was a well-known pest at certain seasons of the year, but I was unable to obtain any signs of the maggots, though I examined very many fallen oranges. All these orchards are planted in light sandy soil, which is banked up in squares round the trees, and irrigated with water drawn from shallow wells. They grow some of the very largest and finest oranges I have ever tasted. One of the Jaffa oval type is common in Turkey, and another is almost hemispherical; the skins of both are very thick, but even when this is removed, they are quite as large as our finest fruits. Most of the oranges grown in this district are shipped to Egypt, where they bring a very good price.

Red Scale (*Aspidiotus auranti*) is very bad in many of these orchards, but the orchardists are beginning to understand how to deal with it, and if they do not spray, they scrub the worst of it off with a brush. Though a few other fruits are grown, the chief crop is oranges, and the next important is pomegranates, the latter being a very valuable crop.

From Cyprus I took the Port Said mail-boat on the 15th of May, reaching Egypt on the 17th, and went straight on to Cairo. Here I met Mr. F. C. Willcocks, Entomologist to the Khedivial Agricultural Society at Giza, which undertakes an important part in the agricultural work of Egypt. It has well-equipped laboratories; a chemical branch under Mr. F. Hughes; a botanical and plant pathology under Mr. W. L. Balls; an entomological under Mr. Willcocks; and several other departments. This society was instituted by the Khedive, and afterwards a sum of money was granted by the Government to pay the salaries of the officers. There are some large experiment plots attached to the Society Gardens, where experiments are carried out by the pathologist, in breeding and experimenting with different varieties of cotton. Among those growing, he pointed out to me specimens of the Carvonica from Queensland, from seed I sent him two years before. It is closely allied, he thinks, to a variety grown in the dry country of Upper Egypt, and considers it may be a very useful addition to their varieties.

As cotton is the staple industry of the Nile Valley, everything that has a bearing on this plant is carefully studied, and the insect pests of cotton are well-known. The commonest and most destructive is the Cotton Boll Worm, the larva of a handsome little green moth (*Earias insulana*), closely allied, if not identical, with the cosmopolitan species that is well-known in

Australia upon our cultivated experimental cotton plots at Hawkesbury College, and has also been recorded from Moree, New South Wales, feeding upon the "wild cotton bush" (*Hibiscus sp.*), and was recorded by me under the name of *Earias fabia*.

This moth, whose caterpillar has very similar habits to the American Boll Weevil, bores into the small cotton bolls when they are well formed, and through the injury causes the bolls to fall off without developing. This moth, with such habits, is a very difficult pest to deal with, particularly in a crop like cotton; and if ever cotton is grown commercially in Australia, it will be a pest we will have to consider.

There are several very destructive cut-worms that do damage to cotton. Among the worst is the cosmopolitan Noctuid Moth (*Agrotis ypsilon*), also a pest on field crops in Australia. The caterpillars come out and feed upon the "burslam," a cultivated clover which is grown in plots among the cotton, and then from this attacks the foliage of the cotton plant. Labour is so cheap that this is partly controlled by hand-picking the caterpillars and destroying them. Another cosmopolitan cut-worm is *Prodenia littoralis*, which, however, lays its eggs in clusters upon the leaves, so that, taken in time, large quantities can be hand-picked before they hatch out, and children are employed for this work. Another similar moth, but smaller, is *Caradrina* (*Agrotis*) *exigua*, which also damages the foliage. Though all the latter do a good deal of damage at times, the cotton boll worm mentioned first is by far the worst pest, and was estimated to have destroyed £1,000,000 worth of cotton in Egypt in 1904.

Two other cotton pests are a small plant bug (*Oxycarenus hyalinepennis*) and the cotton aphis (*Aphis gossypii*), which suck up the sap and damage the leaves.

The fruit industry is not important about Cairo, but a certain amount is grown in a more or less irregular manner. Where oranges are grown in the gardens they are very subject to infestation by the Round Scale (*Aspidiotus ficus*), which appears to be the worst scale insect here; on the other hand there is no Red Scale, though *Aspidiotus auranti* is so common in Cyprus, and must have been imported over and over again with oranges from that island. It is known in Egypt as the "Red-spotted Scale."

Among other scale insects, *Asterolecanium pustulans* is found upon many trees, but is chiefly a pest upon figs. *Icerya purchasi*, the Cottony Cushion Scale, is established there, but *Icerya aegyptica* is the great garden pest among all the mealy bugs.

One of the worst wood-boring beetles that damage the shade trees (*Acacia lebbek*) planted along the street is the "Lebbek" (*Xystrocera globosa*). I also noted several curious gall-making Psyllids upon the shrubs.

The collections at the entomological laboratory were carefully examined for specimens of fruit-flies, but though there are some specimens of *Dacus longistilis* in the British Museum said to have come from Egypt, Mr. Willcocks has never obtained the flies here. I, however, obtained a fine series of *Ceratitis capitata*, our introduced pest, bred from infested oranges obtained in Cairo. This is the first record of the Mediterranean fruit-fly from this part of Africa, though it is well known in the north-west and south.

At the School of Agriculture I met Dr. Fletcher, the Director, who gave me some information about the institution, which is run by the Government, and has a large teaching staff. One of the most important stations in Egypt is the Wellcome Research Laboratories, established some years ago in the

Gordon Memorial College at Khartoum, where Mr. H. H. King is Entomologist, but I was unable to find time to go so far inland. These laboratories have done some very fine work on the lines of the Tropical Schools of Medicine, in dealing in particular with the sleeping sickness and in studying the habits of biting and blood-sucking flies, and other insects that transmit so many tropical diseases. They have issued several very valuable reports, and state the objects of their work in the last one:—"To promote the study, bacteriologically and physiologically, of tropical disorders, especially the infective diseases of both man and beast, peculiar to the Soudan; and to render assistance to the officers of health and to the clinics of the civil and military hospitals."

I also called at the Survey and Lands Department, and met Captain Lyons, who showed me the maps they are charting of the whole of the Nile delta, cotton area, and the systems of irrigation carried out. At the Veterinary Branch I met Mr. Littlewood, who said that their records of the number of stock in the country were very irregular, and they had no idea of the number of horses or sheep in the country, but last year (1907) it was estimated from the returns that there were 718,000 cattle and 761,000 buffaloes, while there was a very large import of cattle and camels from Syria, Soudan, Servia, and Russia. There are a great number of stock diseases. Cattle tick is very common, and causes many deaths. Cattle plague is a very serious difficulty and so is "malarial fever." Anthrax is very common, but difficult to get at, because the owners never report the disease. He mentioned a case which was discovered in a village by all the old women dying in a mysterious manner. On inquiry it was found that their business was to make the cattle dung into cakes for fuel. The cattle of the village had died of anthrax, which the women thus contracted.

I would point out the danger of the introduction of the form of "sleeping sickness" with which camels become infected, often wasting away for a couple of years before they recover. We have many biting flies that might easily become the agents in the spread of this or kindred diseases in Australia.

Leaving Port Said on 20th May, I reached Bombay, India, on the 29th May, where I immediately called upon the Acting Colonial Secretary, who advised me to visit Poonah before I went across to Bengal. At Poonah I met the Assistant Director of Agriculture, who gave me some reports upon the crops, and then sent me on to the Agricultural College, where I met Dr. H. H. Mann, who is a well-known entomologist in India. He showed me the plans for the new college now in course of construction, and which will accommodate 200 students. Pests, particularly scale insects, are not common in this part of India. After mangoes, which are the universal fruit all over the country, large quantities of figs are grown in the district of Poonah. Dr. Mann had not noticed any fruit-fly in the local fruit, but promised to keep a look out, and send me specimens if found. From Poonah I returned to Bombay and took the Calcutta train, reaching Chheoki railway station, where I met Mr. Howlett, second Imperial Entomologist, who had come down from Pusa to meet me, and with him went on to Allahabad. Here we spent a day among the melon gardens, where we found many fruit-flies scattered about. We experimented with citronella oil to see if it would attract them. On examination we found that the common melon fly was identical with the species so common in Hawaii, and named by Coquillet *Dacus cucurbitæ*. From Allahabad went on to Cawnpore and visited the Agricultural College, and met Mr. Hayman, who was on the eve of leaving the position of experimentalist. Returning to the station we came on the same evening to Lucknow, and the next day visited Karori village, where

we spent the morning among the native gardens, and collected some fruit-flies of another species. Mr. Howlett remained at Lucknow and Allahabad, so accompanied by his man I went on that night to Derha Don, the headquarters of the Forestry Department, where Mr. Stebbing is Forest Entomologist. I saw the museum, but Mr. Stebbing was away on tour.

Returned to Allahabad, met Mr. Howlett, and went on to Pusa and met the officers of the Imperial Research Laboratories. Here Mr. H. Maxwell Lefroy, Imperial Entomologist, placed the whole staff at my service, and with Mr. Howlett carried on a lot of experiments with fruit-flies, which are very numerous in this part of India. We found that citronella oil had a wonderful attraction for two species of fruit-flies (Dacus), but that none of the melon flies (*Dacus cucurbitæ*) ever came to the oil. We also collected many specimens, bred others, and compared all the specimens in the entomological collections. The Pusa Research Laboratories are supported by the Government of India, and are fitted up with all the latest improvements. The staff had just removed from their temporary quarters into the new building; it consists of two stories, in which all the laboratories are placed. The entomological laboratories are very well fitted up, and have very extensive collections; these are all kept in teak boxes placed in racks around the walls. There is also a very fine insectarium in the grounds, and a silkworm house. The staff consists of Mr. H. Maxwell Lefroy, Imperial Entomologist; Mr. Mason, Assistant; and Mr. Howlett, Special Imperial Entomologist, to work at diptera, biting flies, &c., ranking as second Imperial Entomologist. There are eight native assistants, six artists, one engraver, a clerk, and a number of attendants. The insectarium has an officer-in-charge, with artists and assistants.

In each Province there is also a Department of Agriculture, where there is usually a native entomologist attached to the staff. At Madras we visited the Provincial Department of Agriculture. Mr. T. V. Ramahrishna Aiyar is in charge of the entomological work, and has several assistants in his office, where there is a fine collection of economic entomology. These provincial entomologists, to a certain degree, work with the Imperial entomologists. They look up all local pests and furnish reports and specimens of any serious pest for them.

I went over the plantation where lac insects have been introduced and are doing very well. It is expected that this will be a very profitable industry if the insects once obtain a footing in the jungle. They are also carrying out a number of experiments in cultivating the Indian Silkworm Moth (*Attacus ricini*), which feeds upon the castor-oil plant, a food plant that grows very freely on all waste land.

After a very interesting time at Pusa, accompanied by Mr. Howlett, I left on the 16th June for Calcutta, reaching there on the following morning. We found the Director of Agriculture away, but went on to the India Museum, where Dr. Allingham placed all the collections of Diptera in our hands, and we went carefully through the fruit-flies and other economic specimens. Leaving the same night we reached Madras early the second morning, and after visiting the Department of Agriculture, where Mr. Aiyar joined us, left for Bangalore the same night.

At Bangalore we spent five days among the orchards and public gardens, collecting infested fruits, and catching fruit-flies with citronella oil. It was in this locality that the West Australian Entomologist collected all the parasites he sent to Perth last year; he stated that fruit-fly was very rare in Bangalore, but our experience proved that fruit-flies are as abundant in this district as any place in India. Mr. Aiyar, who had bred many of the fruit-fly

[*Photo. by H. Maxwell-Lefroy.*

Insectarium at the Imperial Research Laboratories, Pusa, India.

parasites, said that he only bred them from ripe guavas late in the season; and one of the nursery men informed me that for the last eight years all the guavas in the Bangalore district had been destroyed by fruit-fly maggots. Most of the mangoes that ripened on the trees or fell to the ground were infested with fruit-fly maggots, and quite a number that we had on the hotel tables were more or less infested.

The Mango-leaf Hopper (*Idiocerus*, sp.) is very abundant in all the gardens; they make quite a distinct sound as they fly against the leaves. There appears to be several species. There is a small Hesperid butterfly that breeds in the pomegranate, and an unknown species damages the Jack fruit. There is a new orchard, laid out on Australian plans, being cultivated by Mr. M. J. Paul, of Mildura, who has formed the Mysore Fruit Company. They have 40 acres of grapes and other fruits under crop, and can find a ready sale for a great deal more than they can yet grow, so they propose to plant a large area, and go in for fruit drying. Mr. Paul, however, was not considering the numerous insect pests or the fruit-eating crows which are attacking the grapes already. Returning to Madras I left for Tuticorin, *en route* for Colombo, Ceylon. I reached the former place at 6 p.m. the following day, and after getting on board ship reached Colombo early on the morning of 27th June.

At Colombo I called on the Secretary of the Agricultural Society, and finding him out, went on to Mr. K. Bamber's laboratory. Mr. Bamber, chemist to the Agricultural Branch of the Government, was just leaving for the Malay States; he advised me to go up to the Royal Botanic Gardens at Peradenyia by the afternoon train. This I did, reaching the rest-house at 7 p.m. Next morning found the officers of the garden, and also Mr. West, Acting Entomologist during Mr. E. E. Green's absence. We experimented with different oils in the gardens, and captured a great number of *Dacus*, sp., though the fruit season was practically over. In going through the collections, I found a series of a very curious fruit-fly, genus *Ceratites*, allied to our Mediterranean fruit-fly, but evidently closely allied, if not identical with, the species described some years ago in the Indian Museum Notes, by Coates, as the Beluchistan Melon Fly. Accompanied by Mr. West, I visited the great tea district of Bandarawella, and examined a pest, one of the Cup-moths or Slug-moths, that was damaging the tea in several plantations. Here also we saw the Shot-hole Borer, probably one of the worst tea pests in Ceylon. This is *Rhizobius fornicator*, which bores into the twigs and lays her eggs in the galleries, where the larvæ hatch and feed, causing the branches to die and snap off when touched. No effectual method is known of checking it, except pruning hard and burning everything. As the planters turn all the cuttings into plant-food by burying them in the soil between the rows and letting them rot, it would be very difficult to get them to adopt this method.

The plantations are in many places planted with shade trees; among them are large quantities of our Silky Oak (*Grevillia robusta*). These are kept down by topping every season, and stripping all the leaves off the trees: they are scattered over the surface between the rows of tea plants to keep the soil damp. Large quantities of dadapes (*Erythrina lithosperma*) are used in the same manner, and as they give more shade and the foliage is renewed more quickly, they are coming into general favour. Tea is planted either with rooted shrubs or with stake planting. If the latter method the seeds are first germinated, and two are placed in a prepared hole beside a stake; if both grow the second is pulled up, and used to replant holes where they have missed. Tea is a very hardy plant, growing right up the rugged mountain sides in clefts in the

rocks, and carries about 3,000 plants to the acre. Our host, Mr. Duncan, said he controlled about 14,000 acres on various estates, and the average yield of tea all over the island is 400 lb. of dried tea to the acre, and it takes 400 lb. of green leaf to make 100 lb. of dried tea. The pruning varies at different altitudes. In the lowest lands in which tea is grown the plants have to be pruned every year, higher up the foot-hills every second year, and the plantations on the tops of the hills only prune every third season. The commercial tea plant is, therefore, never allowed to attain a height of more than 2 feet to 2 feet 6 inches in height.

Returning the following night to Peradenyia I met Dr. Willis, Director of the laboratories, who advised me to go up to Jaffna, the old Dutch capital of Ceylon, in the extreme north of the island. Travelling all day I reached Jaffna late the same night (245 miles), where two officers of the Agricultural Department met me and made all arrangements for the following day.

The whole of this part of Ceylon is a flat, sandy plain, covered with cocoa-nut palms and palmyra palms, the chief wealth of the natives; and my guide, who owned a number of cocoa-nut plantations, said that he would sooner deal in them than rubber plantations. The cocoa-nut palms are manured by tying the cattle to them at night. They will bear a crop in from five to six years. Copra (the dried kernel) is worth from 50 to 80 rupees a ton, the former price paying well.

We drove out through the country to some mango gardens, and then out among vegetable gardens, where there were a great number of onions, bringels, chili, and melon patches, all watered from shallow wells. We could find no fruit-fly by spreading citronella oil, but soon found many melons badly infested with fruit-fly maggots, and collected a number, from which, on board ship, after leaving Colombo, I subsequently bred a number of the Indian Melon Fly (*Dacus cucurbitæ*).

After going through the markets I called upon Sir William Twynem, who has a very fine collection of technical and ethnological interest, made during his long residence in Ceylon. Returning to Colombo, I spent the next morning at the Colombo Museum, where Dr. Wiley showed me all the entomological collections.

I left Colombo for Freemantle on the 6th of July, arriving at Freemantle on the 16th. As soon as I had landed I went up to Perth, and called at the Department of Agriculture, where, in the absence of the Entomologist in America, and the Director in the country, I met Mr. Hooper, who introduced me to Mr. Newman, the Assistant Entomologist. He showed me over the library, and the hot-house used as a breeding room or insectarium.

In the latter there were several breeding-cages, with quantities of fruit-fly pupæ placed on the floors of the cages, and a quantity of fruit, in a great part of which Mr. Newman informed me he had placed a number of fruit-fly larvæ under the skin, for the parasites to lay their eggs in them. There were at least three different species of parasites in the cages, those in the guava bred from guavas bought, packed, and forwarded from Bangalore by the West Australian Entomologist the year before. Many, Mr. Newman informed me, had been distributed in large numbers among the orchards, but it was too soon to look for results. This was practically the extent of their insectarium, except a parasite of the cabbage aphis, which they were breeding to send out to the cabbage-growers about the gold-fields. As regards a pinned or mounted reference-named collection, Mr. Newman said the Department had no collection of any kind; that there was an insect cabinet in the room full of fruit-flies and other economic specimens, but it

was the private property of the West Australian Entomologist, and was locked; and as that gentleman had the keys with him in America, they could not be shown to me.

On the following morning I presented my credentials to the Director of Agriculture, Mr. Despessis, who talked over the question of parasites with me, and stated that they had with introduced parasites destroyed the olive scale (*Lecanium oleæ*) in the gardens around Perth, had destroyed the cabbage aphis on the gold-fields, and were going to destroy the fruit-fly with the Indian parasites. He asked me if I had seen the parasites in the departmental breeding cages, and then, when I asked him if he could show me any bred or breeding in the orchards or gardens, said that it was the wrong time of the year, and that there was nothing to be seen in the orchards.

I then asked him, if I stopped another week in Perth, could he show me anything more in regard to parasites in the orchards. He distinctly answered that there was nothing more to show me, either in the office or orchard; whereupon I told him that I should leave for Adelaide next day, but was quite prepared to remain till the following Thursday if there was anything to investigate. I make this statement carefully, for before I reached Adelaide the West Australian representative of the *Daily Telegraph* of Sydney wired across the statement, on the authority of the Director of Agriculture (Mr. Despessis), that "he had asked me to remain a week in Perth to investigate the value of parasites, and I had point blank refused."

Left Perth on the 18th of July, reaching Adelaide on the 23rd, and Melbourne, by the overland express, on the 26th, and reported myself in Sydney on the 29th, having been away one year and three weeks.

PART II.

Notes on Parasites or Insects that have been introduced from foreign countries to check or exterminate injurious insects.

Parasites, and their value and limitations in controlling injurious insects of the garden and orchard.

One of the most interesting problems in the study of economic entomology is that of how far we can avail ourselves of the services of predaceous or useful insects that devour the injurious species, by introducing them from other countries to check or exterminate in an artificial manner native pests, or foreign accidentally-introduced ones that have become pests in their adopted home.

The subject is such a fascinating one, that most people are apt to rush to conclusions before the matter has been investigated from all points of view.

After many years' study in Australia, both in the field and laboratories, after information received personally from entomologists, horticultural commissioners, orchardists, and inspectors during my extended travels, and after careful reading of the many reports, bulletins, and newspaper cuttings issued, I propose to state my views on this problem, and shall quote in conclusion the opinions of some of the leading authorities on the question.

It is a fact that, if it were not for the countless millions of parasites (the majority of them so minute that their work is never observed) which swarm in our gardens and fields, there would be such an overwhelming multitude of caterpillars, grubs, aphides, and scale insects at work, that there would not be a green thing on the face of the earth. Nature in this abundance of natural checks has provided for this balance of power, and it is so maintained under the ordinary natural conditions of the native forest and plains. Thus probably not more than 5 per cent. of the millions of eggs laid ever reach maturity and develop into the adult insect.

Though there are many varieties of parasites, they can be broadly divided into the two very distinct groups for our purpose. First, the predaceous insects, parasites that feed directly upon the injurious insects, such as the ladybird beetles (*Coccinellidæ*), which may be called external feeders; and, next, the insects that, looking for a home for their young, deposit their eggs within the body of the pest insect by means of an ovipositor (a hollow, produced needle-like process at the tip of the body), and from which hatch out the maggots—that eat up their host, and finally pupate under shelter of its skin or in little cocoons in its body. This class of parasites may be called internal feeders, and comprise the immense army of microscopic wasps and flies.

From their size, colour, and activity the fact that ladybird beetles were useful insects was well known by entomologists at a very early date, and in Kirby and Spence's Entomology, published in 1816, the authors called attention to the value of the common English ladybird beetle to the hop-growers in devouring their great pest, the hop aphis, in the south of England.

"If we could but discover a mode of increasing these insects at will, we might not only clear our hot-houses of aphides by their means, but render our crops of hops much more certain than they now are."

This is one of the earliest suggestions made regarding the artificial production of parasites. It is rather a significant fact that though this lady-bird (*Coccinella septempunctata*) is often so abundant in Kent that they are either blown out to sea in such quantities that the returning tide sweeps them up in long ridges along the sea shore, or else they cause quite a scare by swarming into the houses in the summer time; yet the hop aphis regularly occurs every few years as a very serious pest. I, with many of the leading entomologists of the world, contend that, while we quite recognise the importance of parasitic insects in the work of keeping down insect pests under natural conditions of climate and cultivation in their own land, yet we certainly dispute the statements continually being made that every pest (and they even proposed to cure the bacterial disease "pear blight" in California with a parasite) can be dealt with by finding and introducing parasites from the country whence the pest is supposed to have originated. Many entomologists and collectors are so imbued with this idea that they have formulated the statement, "That every insect is kept in complete check in its native home by a parasite; therefore, only find the exact locality of an insect that has become a cosmopolitan pest, and there you will find its parasite; introduce that parasite, by any means, into the adopted home of the cosmopolitan pest and it is exterminated." Many of them even go further than this; they claim that we should give up all artificial or mechanical means of killing off our pests, for it is a waste of time and money; that we are foolishly wasting money in spraying, fumigating, and burning up infested fruit and cuttings, because we are killing all the native and introduced parasites, and not giving them a chance to prove themselves. Now it is only rational to demand that when money has been expended in introducing a parasite into the orchards it should be protected, and if this is carried out to a logical conclusion, we must stop all other methods. This has been done in certain parts of California, under the powers possessed by the Horticultural Commissioners; and, if the theory be sound, should, in the experiments that have been going on for twenty years, have proved itself. But if we turn to the last report of the Fruit-growers' Convention, held at Riverside only last May, we will be convinced that parasites alone have not achieved the end that their advocates promised the orchardist.

At the present time, too, both the State and Federal authorities are carrying out elaborate experiments in fumigating in southern California because the scales have become so destructive on the citrus trees. Here also (page 49), Mr. Maskew, a well-known authority in California, says: "The status of parasitism in the citrus orchards, in my opinion, is this—the United States Department of Agriculture, through the Bureau of Plant Industry, has proven to you that to have your fruit carry well, and hence sell profitably, it must come to the packing-house clean. The citrus orchards of southern California to-day cannot send the fruit to the packing-house clean. You can draw your own conclusions from that."

If wishing for popularity, nothing could be simpler than to advocate the adoption of parasitic methods, for there is a certain amount of plausibility in the theory of introduced parasites to eradicate all pests that appeals to the general public, who have not gone into the why and the wherefore of the matter, and particularly to the orchardist, who naturally wishes to give up spraying and fumigating, if he can simply turn out a colony of parasites, sit

back, and they will do the work. As the results of the parasite introductions become better known, and the misstatements and exaggerations with which they have been surrounded are swept away, there will be a revulsion of feeling; results credited to parasites will be explained in other ways; the introduced parasites will take the position in our methods of eradicating pests that their services deserve, and will not be extolled as a cure for every ill connected with horticulture.

Any observant person can follow the rise of insect life in its native land under natural surroundings. For example: A tree becomes so badly infested with scale insects that they form a regular incrustation on the stem and twigs; then, as with one of our commonest eucalyptus scale insects, *Eriococcus coriaceous*, we soon find a host of hungry insects taking it in hand. Several of the black ladybird beetles (*Rhizobius*) devour the scale both in the beetle and larval state; then, too, the eggs of the pretty little moth *Thalpocharis coccophaga* are placed among the scale by the moth, and the resultant larvæ not only devour the scale but use up portions of their outer skin to construct the stout cocoons under which they are well protected. Other parasites also are attracted by the abundant food supply, until the twigs are only fringed with ragged bits of scales, and before the season is over the tree is apparently clean and quite recovers its former vitality. If, however, you visit the same bush the following season you will be almost sure to find it more or less infested with the same scale from the survivors of the last year; it was only the superabundance of scale that had been destroyed; and the infestation will increase until it again attracts insects looking for food, which again breed up.

Most of the aphides, that are such pests to roses, peach trees, apples, and other crops, simply swarm and increase so rapidly that one might think they are going to smother the plants infested; but as soon as they become in this state, the syrphid flies, ladybird beetles, lace wings, and hymenopterous parasites, attracted to their food, take up the work of cleaning the tree. One cannot walk through a vegetable garden on a fine summer day without being struck with the immense numbers of tiny little insects floating about in the sunshine and hovering over the plants; most of these, if examined, would prove to be tiny little wasps that are depositing their eggs in the cabbage aphis; there are thousands and thousands of them busily at work in every cabbage garden in the State where the aphis is in evidence.

It is a question of cause and effect; the pest must appear before the parasite or there is no food, and in the forest and uncultivated land this works out its own salvation; but under the different conditions of the growth of cultivated plants and trees, we cannot afford to wait until they are badly infested. The struggle for existence is quite as an important factor in the insect world as among the larger creatures; and in this fight for life we find not only that the insects that prey, but also those that are preyed upon, evolve special structures to enable them to escape from their enemies; just like the case of the battleship being first protected with 9-inch armour plate, and then the cannon being invented that can send a projectile to pierce that 9 inches of plate. Thus a moth produces silk and blends it into a solid mass when it spins its stout cocoon to protect the helpless pupa; and as a general rule the caterpillars that place their cocoons in the most dangerous exposed places make the stout cocoons, while those that hide in crevices have only a flimsy silken envelope. In the same way that section of the coccidæ known as mealy bugs are much more easily destroyed than the scale insects like the *Lecanium* and *Aspidiotus*, which are closely protected by a thick skin. These structures, so important to the hunted, are circumvented by

the hunters, who are in turn furnished with a most wonderful apparatus, known as the ovipositor; it is formed of several parts, all used in pricking the skin of the victim and when depositing eggs in the living host; the shape and structure of this ovipositor often tells the naturalist what kind of insect he may expect to find its possessor attacking. Some little parasitic wasps that lay their eggs upon the active leaf hopper, which they first have to catch and then hold, have remarkable pincer-like processes upon their legs by which they are enabled to accomplish this without any difficulty.

Another important factor in the sole control of pests with useful insects is that the latter cannot eat up all their food supply, or else they in turn would die out, while if they leave even a small percentage in the orchard (in particular) their value is very much discounted.

Again, in a time of short commons the ladybird beetles and their larvæ eat their weaker brothers and even their own eggs, and the savage little larvæ of the lace wings eat friend and foe without any discrimination. Several instances have been recorded of introduced useful insects which, having left what was their natural food in their own home, have turned their attention to the larvæ of a native useful insect. An introduced hymenopterous parasite did a great deal of damage to one of the native ladybird beetles in America some years ago by parasitising its pupæ.

Changes of climate make an immense difference to insects; and thousands of parasites have been forwarded from temperate climates to semi-tropical countries, with the result that, though surrounded with food when liberated, they have wandered away and died. This was the case with large quantities of ladybird beetles that we sent to India and Ceylon some years ago; there was plenty of food for them, but they never became acclimatised, so the experiment was dropped, and other means were taken by the tea and coffee planters.

Again, nearly every species of ladybird beetle has its own particular kind of food; some only touch mealy bugs, others aphis, while many that live among foliage infested with hard scales have not the power to turn over the hard shield or to bite through it, though they greedily devour the armoured scale if it is turned over for them. Their food is the young larvæ when they emerge from the protective parent scale under which they have been hatched.

It has also been the habit to credit the introduced insect with all the dead scale upon the infested plant, whereas we always find on a badly-infested tree a large percentage of dead scales that have died or remained undeveloped from many other causes. The native useful insects, perhaps more numerous than the introduced ones and often quite as active, are ignored in the glowing and usually exaggerated accounts given by the parasite introducer. Now, if the action of the ladybird beetles is so doubtful and variable, and there is no disputing these facts, it must be quite evident to the reasonable man that the fluctuations and changes in the life of minute hymenopterous and dipterous parasites must be very much more complex, and their establishment in a new country very difficult, for every parasite has an enemy as well as the other insect. In fact, if the entomologist takes up the breeding out of the minute carnivorous and plant-eating insects found in galls and in the remains of other insects, it is often a work of great difficulty, even for the expert, to say which is the true parasite, inqualine or the hyper parasite.

Let this internal parasite be effective, so that it increases and multiplies until it has destroyed all the pest, then it must either die out or find fresh food supplies; if it is not thorough in its work, it is of no commercial value.

The very fact that we always find plenty of scale where we find the parasites, at once proves that the introduced friend is not up to its work in its native home.

The parasite entomologist says that every insect pest has its effective parasite. If we look closely into the question we see the fallacy of the argument. The exact homes of many of the most destructive cosmopolitan pests are well known, and have been known for many years. Take, for example, the Colorado Beetle or Potato Bug (*Doryphora decemlineata*), with its soft unprotected larva; the Hessian Fly (*Cecidomyia destructor*); the Chinch Bug (*Blissus leucopteris*); the Vine Louse (*Phylloxera vastatrix*); the Cotton Boll Weevil (*Anthonomus grandis*); and scores of just as serious insect pests; yet none of the parasite workers have ever claimed to know their effective parasite. The artificial conditions of the growth of cultivated plants, and fruit-trees in particular, where they are grafted, budded, and then pruned year after year of the woody growth of nature, and the plant tissue that would form this wood diverted into fruit buds and then into great masses of soft tissue surrounding the seeds which we know as fruit, so alter the constitution of the tree that it is not able to resist the attacks of insects, fungi, and bacterial diseases in the same way that the robust seedling growing under natural conditions would. This is undoubtedly one of the reasons why insects are greater pests under intense cultivation.

There is another great factor in the increase of insect pests, that under their natural surroundings were perfectly harmless to cultivated plants and crops; we cut down and burn up the forests and plough up the grass lands, and thus destroy the food supplies of the insects that existed there. Many of the more delicate perish, while the more robust, or those that are fortunate enough to find plants allied to those destroyed in the newly-planted trees or field crops suitable for food, turn their attention to the cultivated things, and adapting themselves to the altered conditions and with a bountiful supply of food, they often increase to such swarms as to prove the very worst kind of pest.

We come across many examples of this in the study of economic entomology, and it is curious to note that they are often not infested with parasites, or that the parasites do not increase in proportion.

We have an example of this in the increase and the wonderful spread of the American cotton-boll weevil (*Anthonomus grandis*) over the great cotton belt of the United States. Originally a native of Mexico, it was described from specimens collected near Vera Cruz in 1843, and was known as a pest to cotton in 1856. In 1893 it had spread pretty well all over Texas; has since moved on over a very large area in Louisiana; and, in spite of all precautions, it is working its way northward, following up the fields of cotton. The State and Federal entomologists are working at and investigating every detail in the life history of this pest. Last January (1908) the United States Department issued a Bulletin, entitled "Studies of Parasites of the Cotton-boll Weevil," by W. Dwight Pierce (Special Field Agent). In this very interesting report twelve micro-hymenoptera, all small wasps, and internal parasites, are recorded as having bred from the larvæ of the boll weevil; but several are doubtful, and only four of them have been obtained in considerable numbers; two mites and two beetles are also placed on the list. Now the genus *Anthonomus*, to which the boll weevil belongs, contains a great number of different species; and the field agent is now studying the known parasites of all the different species, in the hope of getting efficient parasites among them. In Professor Hunter's bulletin, issued in 1905, he points out that though there appears to be very little

hope of exterminating the weevil, yet by planting the cotton early and getting the varieties that mature early, they can obtain much better results than in the late crops; while with good cultivation, planting the rows wide apart, and the ploughing up of cotton fields and burning up of all cotton stalks after the crops are harvested, the pest may be very greatly reduced, and in clean cultivation immense numbers of the adult weevils that hibernate through the winter would be destroyed.

Another example: The Colorado Potato Beetle (*Leptinotarsa decemlineata*) is a native of the Rocky Mountains, where it was, until about 1855, a common beetle on several weeds belonging to the same natural order of plants as the cultivated potato. About this date it became acquainted with the latter more succulent plant. It multiplied in such numbers that it spread from one end of the States to the other; and Saunders, in "Insects injurious to Staple Crops, 1902," says: "It is safe to assert that this pest may to-day be found almost wherever the potato is grown in the United States or southern Canada."

In a very similar manner there appeared what is a very serious pest to the citrus tree in the northern rivers district of New South Wales. When the virgin forest was cleared off the land near Lismore, among other trees growing in the scrub was a "wild finger lemon," one of the few representatives of the citrus family indigenous to Australia. In this a large longicorn beetle (*Uracanthus cryptophaga*) lived, the larva boring holes all through the branches. Orchards planted on this cleared forest land were attacked by a borer, which on examination proved to be the larva of this wild lemon longicorn.

The question is often asked, "Why do the grasshopper, locust, and cut-worm plagues only occur every few years in a very acute state, though we always have a few about?" There are several reasons: First, climatic conditions, such as a very dry or very wet season, check or increase the development of the eggs; next, we find that many of these recurrent plagues gradually increase in intensity for several years until they have reached their limit; then parasites increase in proportion, or fungus diseases, which are spread by the immense number of insects contaminating the feeding grounds, kill them off in millions.

To an observant man it is quite apparent that while great numbers of insects are preyed upon by other insects, Nature makes provision for this in the immense reproductive powers of all insects that are liable to excessive parasitism. The fecundity, apparently useless and wasteful, of some of our great wood-boring moths (*Zeuzera*, *Leto*, &c.) in producing the thousands of eggs contained in their ovaries scattered over the bark, and from which later very few larvæ ever enter the trunk would be appalling but for the thought that they are the probable food supply of some smaller forms.

Australia stands alone in its isolated fauna and flora, so that there are certainly not so many native trees in our forests closely allied to cultivated plants as there are in most parts of the world. If we had not introduced our orchard pests, we had very few in our orchards from native trees.

Before we can go into the question of pests and parasites, it is only reasonable that we should first know something about the habits and life histories of the insects of both pests and parasites before we attempt to alter the balance of nature, and set "bug to fight bug"—a popular saying in the United States. Yet we are often told, in the newspapers and elsewhere, that it is not necessary to be an entomologist to undertake the collection and introduction of foreign parasites; that it is a disadvantage, in fact, for one may be too good an entomologist to be a practical man. The danger of a

practical man who is not a naturalist introducing noxious insects or the parasites of useful insects is very much greater than if the work be in the hands of a trained entomologist who knows his work. The latter may not introduce so many insects, but there is a very much greater possibility of their being of use. Then the question arises, what are we in Australia to introduce? We have found by experience that we can control scale insects of all kinds (which are the orchardist's worst enemies), either by spraying or fumigation; and that for citrus trees there is nothing so effective and rapid, when properly carried out as fumigation with hydrocyanic acid gas.

We find many natural parasites attacking the different native and introduced scales, both ladybirds and internal parasites; but, as in other parts of the world, they will not give us clean fruit unless they are assisted.

We do not need ladybird beetles, for our insect fauna is so rich in Coccinellidæ that they are hunted for and collected by investigators from all parts of the world. In fact, as previously noted, some of the keenest advocates, when ladybirds were the fashion, have lately turned a cold shoulder on these beetles, and claim that the micro-hymenoptera or chalcid wasps are very much superior.

The American and foreign bulletins for the last twenty years have been full of descriptions of new species of parasites. Interesting papers on the development, and calculations based on the percentage that have been bred from different scales and other pests worked out, until results have been shown, upon paper, that in theory prove that each particular pest is doomed to extinction; but in practice there is always some little weak spot that has not been taken into account, the pest raises its head again, and we go back to the old methods. There is no question that, from a scientific point of view, there is not a more interesting study in the field of economic entomology than working out the life histories of these interesting little insects; but when it comes to hard facts, how many of the much-praised insect parasites that have been written up have been a factor in relieving the orchardist or gardener of the labour of spraying, fumigating, and other more mechanical means of checking the ravages of insect pests?

The ideal introduced parasite is one that can be bred in a large State or a private insectarium in sufficient numbers that it can be distributed just at the critical time when the particular pest it destroys is in evidence, which, when it is once liberated in the orchard and garden, can establish itself against all comers in sufficient numbers, adapt itself to its surroundings, and, when its food supply is exhausted or has reached the vanishing point (a natural consequence if it is to be an effective parasite), will either find some other insect to devour, or will hibernate until fresh supplies come into existence.

The discovery of such an admirable parasite has been proclaimed again and again; but it is much to be regretted that it has become the habit of entomological collectors to enlarge upon the great value of their discovery before the insects have reached their destination, and to proclaim, not what it has done, but what it is expected to do when introduced into its new home.

The results of my investigations into the actual importance of the Spanish Codling Moth Parasite (*Caliephialtes messer*), in relation to its value in the apple orchards of California, are recorded in the general part of this report, and have since been borne out by the latest information available. This large black ichneumon wasp was advertised round the world, figured and

described in newspapers and magazines as the "saviour of the apple-grower." We could throw away our squirts and spray-pots, or send them to the lumber-room, said the American newspaper man.

The officers of the Horticultural Commission sent out thousands of specimens, and published glowing accounts of its work; yet in Spain it was unknown, and of no value in destroying codling moth; and at the time it was being written about in the newspapers it had not killed one codling moth grub in the orchards of California. It has now had several years to show what it can do, and, if we are to judge from the statements in the horticultural newspapers, it has done absolutely nothing outside the insectarium at the Commissioner's office in San Francisco.

In the official report of the Thirty-fourth Fruit-growers' Convention of the State of California, held at Riverside last May (1908), Mr. S. A. Pease, Horticultural Commissioner for San Bernardino, in a paper on "Parasites and the State Insectary," says: "The introduced parasite for the wide-spread enemy of the apple-grower, the codling moth (*Carpocapsa pomonella*), is *Caliephialtes messer*. It works well in confinement, when supplied with larvæ or cocoons of the moth; but, after a number of years' trial in the orchards, has no friends to sound its praises."

Speaking of the breeding of several native parasites of codling moth in Cape Colony, Mr. C. P. Lounsbury, Government Entomologist, in his report for 1907, says: "Professor Koebele, an insect collector of international reputation, has told the writer that he has reared six different parasites from the codling moth in California, yet in that country it is about as necessary to spray to save apples and pears from the pest as it in the infested parts of the Cape Colony; and spraying will probably continue to be deemed necessary, notwithstanding all the parasites that may be found and introduced. Considerable interest was aroused at the Cape about two years ago over the alleged success of a parasite (*Caliephialtes messer*) introduced into California from Spain by Mr. George Compere. While in America last year the writer inquired about this insect. It breeds very well in confinement, and has been distributed to various parts of the State; but it is exaggeration to say that it has yet proved of any practical value, or that it has given evidence that it will."

This is the parasite that each of the Governments of the Australian States were asked to pay £1,000 for the privilege of receiving from the Commissioner of Horticulture of California, and the New South Wales Department of Agriculture was severely criticised by the fruit-growers and newspaper correspondents for not accepting the offer.

Besides the larva of a small soldier beetle, which gets under the bandages and devours a few codling moth grubs, I have described four well defined codling moth parasites which infest the larvæ and pupæ; and there are several other hymenopterous parasites that we have bred in small numbers, but none of them are numerous enough to make an appreciable difference to the codling moth pest. The most promising is *Goniozus antipodum*, a little proctotrupid wasp that was described by Westwood, from Adelaide, in 1874; and, though it has been rediscovered there again last year, is still a rare insect after thirty years' existence among the apple orchards.

We have only to study the life history of the codling moth to understand how it has managed to exist, propagate, and hold its own for at least the last thousand years as an apple pest. The tiny egg, too insignificant for the ordinary egg parasitic hymenoptera, is not long in danger, for as soon as the tiny grub is hatched it burrows into the fruit away from danger; there it

feeds, and as it increases in size works toward the seeds of the fruit. Most moths spin a cocoon and pupate at once, but the codling moth does not spin a cocoon in its food, but works its way out through the fruit and drops to the ground if the apple has not fallen before it has finished its larval stage. It does not give its enemies many chances, but drops or crawls out of the fruit in the night and immediately hunts round for a hiding place, the deeper and more secluded the better. In this shelter, however, though it spins a more or less compact cocoon of silken fibre, it does not pupate and at once turn into a helpless pupa unable to crawl away from danger as is the usual procedure of moth grubs; but it remains all the winter a perfect caterpillar, and though enclosed in a loose silken cocoon, it is able and ready to crawl away and hide if disturbed by its shelter being torn down and its cocoon exposed. Its time of pupation is short, a few weeks at most under ordinary circumstances.

The perfect moth has such a wonderful protective tint, working only at night and hiding during the day, that three-quarters of the orchardists have never seen a specimen, and could not identify it from a score of other harmless moths common in the orchard. It has not even the very common habit of the moths of coming to a light, and though a number of "codling moth traps" have been tried with a lamp and oil, they are found to catch everything but the moth for which they were invented.

From the study of the life history of the codling moth, it is useless to expect to find a perfect parasite for this pest in the insect world. We are dealing with highly cultivated fruit and with a highly developed insect that damages it; its instinct of self-preservation is so highly developed that its first duty when it emerges from the apple is to hide in the deepest cracks and crannies in the tree trunk out of sight and reach of its enemies.

The other great fruit pest, or rather group of fruit pests, are the fruit-flies, of which the cosmopolitan species *Ceratitis capitata* is known in Australia as the Mediterranean Fruit Fly. We have another example of an evidently worthless and much praised parasite for this fly in the notorious Staphylinid beetle, said to be a complete parasite of this particular fruit-fly. It was collected in Bahia, Brazil, and introduced into Western Australia by their entomologist, who took several trips to that part of South America under the impression that this was the native home of this particular fruit-fly.

Wonderful stories were told of its voracity and its deadly enmity to fruit-fly maggots and pupæ; how it had been securely established at great cost to that State in their citrus orchards; and it was urged by our fruit-growers that we should obtain this parasite at any cost; yet it had not been proved that it had killed a single fruit-fly maggot in a West Australian orchard. So much attention, however, was called to this reputed parasite in the fruit-growing world, that the entomologists of Cape Colony and Natal urged their respective Governments to investigate the matter. Cape Colony voted £500; Natal, £375; Transvaal, £300; and Orange River Colony, £125; or a total of £1,300 to provide funds. Thus provided, Messrs. Lounsbury and Fuller set out for Bahia to secure supplies of this Staphylinid beetle, to introduce them into the South African orchards.

How they succeeded, and what they thought of the value of this parasite, is told in Mr. Lounsbury's Report, "Natural Enemies of the Fruit Fly," published in the *Agricultural Journal* of Cape Colony, September and October, 1905.

Both these gentlemen are strong advocates of the introduced parasite theory, so that their reports must be taken as an impartial review of the whole question; and though Mr. Fuller did not remain very long in South

America, Mr. Lounsbury took an extended trip down the South American coast, but found even worse conditions in fruit-fly infestation than he had in South Africa. In the district round Bahia, described by the West Australian entomologist as being "the fruit district of Brazil" and yet almost free from fruit-flies on account of parasites, Lounsbury said he found no commercial orchards; and speaking of the Brazilian cherry he says: "My impression is that nearly every fruit gets punctured if allowed to fully ripen upon the plant." Mr. Fuller counted 280 puparia from one lot of pilangas he gathered, and from them emerged 124 adult fruit-flies and 77 parasites; from another lot he collected on 11th March in the same locality he obtained 141 puparia, and from these emerged 47 fruit-flies and 28 parasites. The latter consisted of 221 fruits—large and small, ripe and unripe—shaken from the bushes. The extent of parasitism in both cases works out at about 38 per cent.

The parasite is a minute wasp (*Opiellus trimaculatus*). Fuller says: "The effective parasitism of this species reaches its maximum in small fruits with thin pulp, and the effectiveness falls appreciably in proportion to the depth or thickness of the pulp of the fruit attacked by the fly."

None of these hymenopterous parasites, though so abundant, were considered sufficiently effective, and no efforts were made to introduce them into Africa. It was the Staphylinid beetle that these investigators had gone to procure, but with careful search they could not find any. It may have been the wrong season, but it does not say much for the parasite if the fruit-flies were busy all the year and the beetles only a few months. In fact, the case was that the fruit had to become rotten with fruit-fly maggots, and fall to the ground before the predaceous scavenger beetles could take a hand in the destruction of the maggots.

Messrs. Lounsbury and Fuller returned to South Africa without getting a single effective parasite, or even seeing a Staphylinid beetle at work in the orchards, and Mr. Fuller's remarks in the journal of the Natal Department of Agriculture are even more emphatic than Mr. Lounsbury's in their condemnation of the Staphylinid beetle.

Yet, in his report, "Introduction of the Fruit-fly Parasite (*Journal of the Department of Agriculture*, 1904), Mr. Compere concluded with the following statement: "The Staphylinidæ beetles beyond question destroy the major part of the fruit-fly maggots in Brazil, and also destroy a great number of parasites as well, eating every maggot with which they come in contact, not discriminating between those parasitised and those that are not." He says, too: "In Brazil, the same as in India, nature's forces controlling these destructive fruit-flies is complete." Only a few months later Lounsbury and Fuller found that all down the Brazilian coast it was difficult to obtain a fruit that had not been punctured by a fly. The officers of the West Australian Department of Agriculture have known quite well for some years that this beetle is not only no check upon fruit-fly in the West Australian orchards, but that it had never even been established outside their insectarium, and there they died out; yet they still publish glowing accounts of its value, as can be seen in their official bulletin, "The Selector's Guide to the Crown Lands of Western Australia." On page 20, the successful introduction is stated as a fact. "Fruit Pests: Successful Work of the State Entomologist." Now, in regard to the statement that nature controls the destructive fruit-flies in India, if it means that they are kept below the point where they become a pest, it is certainly not true.

The fruit-flies of the genus *Dacus*, belonging to several species, are so abundant in all the fruit-growing districts of India and Ceylon, that

commercial fruit-growing is just as difficult a problem as it is in Australia, Africa, and South America. If the fruit has to become rotten with fruit-fly maggots before parasites can be bred out, as it does in the guavas and mangoes in Bangalore, whence these parasites were obtained, and where the two species of fruit-fly, which the parasites infest, simply swarm through the gardens and parks, they might just as well face the situation at once, and make their orchardists clear up and destroy infested fruit, as is being done in all parts of the world at the present time. I was told in Perth, Western Australia, "That we cannot get our orchardists to clean up their orchards, so we must have parasites."

All the evidence shows that while we may succeed with parasites to a certain extent, and in some instances for scale insects, aphis, and even cut-worms, and other lepidopterous larvæ, yet, we may make up our minds that under the present conditions of fruit-growing, we will have to resort to other methods in reducing these two pests (codling moth and fruit-flies). The life history of the true fruit-flies is just as peculiar in its way as that of the codling moth. The female fruit-fly punctures the ripening fruit with a wonderfully constructed ovipositor, at the same time depositing her eggs well through the tough skin in the tissue beneath, and thus from the very first moment the eggs are in a much more secure position than even those of the codling moth. When the eggs hatch, the tiny moving maggot, enveloped in the decomposing tissue of the fruit, is a very difficult host for the hymenopterous enemy on the outside to locate and stab while depositing its eggs in the maggot, and as the maggots very soon work inwards they soon get beyond the range of any parasite, especially when deposited on such fruits as peaches and oranges.

Therefore, while in the maggot state, sheltered in the fruit upon the tree, the fruit-fly maggots are safe from most enemies. Then, in the ordinary course of events the damaged fruit falls to the ground, and the maggots if not full grown will remain in the decaying matter, and are still safe from most enemies. The majority of them burrow into the ground underneath the fallen fruit, and are still out of sight of their enemies; and it is only when the fallen fruit is disturbed before they have burrowed into the soil, that the predaceous parasites have the chance of destroying them. Once hidden in the ground they are comparatively safe from other insect enemies. I consider, as do nearly all leading entomologists who have given the matter of fruit-flies any attention, that it is very improbable that any internal parasite will ever make any impression on this pest in the case of commercial fruit, such as oranges, peaches, &c. In all cases where parasites have been bred, it has been from small, wild, or hard-fleshed fruits, and though parasites may be quite numerous among some of the wild fruits, yet they are not able to injure the larvæ in large fruits.

The parasites in the Mexican Fruit Fly (*Trypeta ludens*) have never, as far as I could learn, been bred from infested oranges, but from small fruit, like the guava and native mango. The parasites in southern India are bred from infested guavas, not from the thick-fleshed mango, in which the Indian Fruit Fly (*Dacus ferrugineus*) is common; and among the many thousand Mediterranean and Queensland Fruit Fly larvæ and pupæ we have handled and bred from citrus fruits and peaches, we have only bred a few odd parasites. It is one thing to demonstrate to the public the ability of a hymenopterous parasite to deposit its eggs in the exposed larvæ and pupæ of codling moth or fruit-fly; but quite another for that same parasite to work or do any ood in the orchard.

If a system or theory be true, it will not require to be bolstered up with misstatements and half truths; and while American, European, and Australian economic entomologists are quite ready to acknowledge that the field of experiments with parasites is a wide one, and worthy of scientific investigation, as is shown by the work of many of them, they do not subscribe to the Californian school, who claim that everything can be controlled with the spreading of all kinds of parasites; that if you have codling moth, scale, or fruit-fly, just send into the office of the Horticultural Commissioners, and by return of post you will have a package of parasites of the particular pest forwarded, which you have only to liberate, and the insects do the rest. In fact, the existence of such a theory as universal parasitism has not only done a great deal of harm to the value of economic entomology, but to the producers themselves. In New South Wales it delayed the passing of the very necessary Vegetation Diseases Bill for some years; for, as soon as the Department of Agriculture proposed to introduce a Bill to deal with the orchard pests, they were met with the natural, if mistaken, outcry, "Why should we be made to clean up our orchards, and spend money, when the Department can send out to other countries and get us parasites that will do all that is needed?" "Look at California," we were told, not knowing that under the rule of the State Board of Horticulture the most drastic laws and regulations in the world can be enforced against an infested orchard or larger area, backed by all the powers of the State of California. Cutting down, rooting out, and burning up orchards and gardens, can be carried out without consulting the owners.

Judging from former scares, such as the "White Fly," I am quite certain that, if fruit-fly were to suddenly appear in any of the citrus orchards of California, they would not wait to get parasites, but would have the whole place dealt with at once by mechanical methods.

When, however, we come beyond this branch of the parasitic question, and propose to use a savage, carnivorous ant from another country to destroy young rabbits—as a gentleman in South Africa proposed to send us a few years ago, and was actually done in Texas, where Cook brought a tropical ant from Guatemala to devour the Mexican boll weevil—we come to more serious and wide-reaching results from entomology run mad.

Another phase of the work is the introduction of insects that are injurious to plants in their own country to destroy similar vegetation in another country. Such was the introduction a few years ago, at the instigation of the officers of the Sugar Planters' Association, of all the known insects that destroy the lantana in Mexico into the Hawaiian Islands, to kill out this shrub, which has overrun the waste lands of these islands. This, also, appealed to some of our landholders on the northern coast lands of New South Wales, where the same kind of lantana bush occupies much of the neglected lands from which the forest has been cleared. They entered into correspondence with the authorities at Honolulu, and, on their advice, urged our Government to introduce them, and turn about a dozen sorts of plant-eating insects into the forests of our northern rivers. No thought was given to the utterly different conditions in Australia of our forests. It was, too, and is still, a very doubtful experiment in Hawaii, even if it ever does kill out every root of lantana; but it would have been criminal to allow an introduction of such insects, most of which could do an immense amount of damage to our cultivation and native forests.

In every entomological laboratory let us have a well-equipped, up-to-date insectarium, where the development of both friendly and injurious insects can be studied under natural conditions; and if we find a parasite that is

abundant enough to make an impression upon any pest, let us encourage it by every means in our power. In such studies we will find the key to many problems in economic work undreamed of before the commercial importance of applied entomology came to the assistance of the farmer, the gardener, the merchant, and many other interested people.

There is, however, neither sense nor reason in asserting that because one breeds a number of parasites from some partiular pest that the pest is doomed. Every working entomologist has cabinets full of specimens of insects that he has bred from other insects or galls—all true parasites—but he also knows their limitations.

In conclusion, I would say, let the whole question be judged on its results. Allow that one or two experiments have shown perfect results; yet because mealy bugs or scale insects in a restricted locality have once or twice been destroyed by parasites, that can be no reason why the parasite cure alone should be forced upon anyone.

Its admirers should be perfectly honest; and if a friendly-introduced insect from which, rightly or wrongly, great things had been expected turns out on further trial to be a failure, they should say so; and they should never proclaim results for a parasite till those results have actually been proved in its adopted country, for the wisest can never be sure of the results of any experiment.

Economic entomology is a great commercial science, and those at work for its far-reaching interests could do it no greater harm than by misleading or unproved statements.

I append some notes and the opinions of some of the leading entomologists of the world on the broad question of parasites.

H. Maxwell Lefroy, Imperial Entomologist of India, says, in his "Indian Insect Pests, 1906":—"*Artificial use of Checks.*—A subject that has unfortunately attracted general attention is the fascinating one of using one insect to destroy another. We know that there are parasites, predators, and the like, which destroy insect life. The inference is that we should be able to check all our pests by this means. Entomologists have devoted great attention to this point, with an almost complete record of failure. In one instance, under very peculiar conditions, success was attained, a ladybird beetle being introduced to destroy a virulent insect pest. The particular conditions in this case were that the pest was newly introduced, had no enemies in the locality to which it was introduced, and could be traced to the country whence it came. . . . . No parasite, no enemy, will entirely destroy an insect that is established throughout India, and there is no advantage to be gained by introducing fresh parasites. There is, also, no ground for believing that in the near future we shall be able to artificially employ fungoid and bacterial diseases in the destruction of insect pests; they appear to require special climatic conditions (*e.g.*, very moist heat), and this places the matter beyond our control."

Dr. James Fletcher (Entomologist and Botanist to the Dominion of Canada) says, in speaking about scale insects ("The Report of the Select Standing Committee, Orchard Pests, Insecticides, and Farm Weeds, 1906-7, page 121, Parasites"):—"It has always been a most attractive field of investigation for all entomologists to try and discover, in their original homes, and introduce the parasites of insect pests, which have increased unduly when brought into other countries without their natural enemies. Notwithstanding the fact that some of the best investigators have engaged in this work, and much time and money has been devoted to it, it has been found an exceedingly difficult matter to establish these useful friends in a new home; and it would

appear that it is not an entirely parallel problem to introduce a certain insect which thrives and increases in a new home, and, also, to colonise its controlling enemies. Predaceous enemies and parasites can only thrive and increase as long as they have an abundant supply of the insects upon which they feed, because as soon as they have reduced the numbers of their hosts, so that they do not injure our crops, they have also brought down their own food supply, and to that extent have contributed to their own extinction." Further on, he says:—"*Parasites not as efficient as Spraying.*—Where substantially clean fruit must be had, as for shipping and export purposes, spraying, or some other direct means of control, must be practised; and now that an inexpensive tree-wash for the San José scale has been discovered, it is very much to the advantage of everyone to spray regularly, rather than trust to control by natural enemies."

In a paper, "Scale Insects and their Enemies in California," contributed by Professor J. B. Smith, State Entomologist in New Jersey (Bulletin 6, United States Department of Agriculture, 1896), he makes the following statements, that are now more or less endorsed by Mr. S. A. Pease, in his paper, "Parasites and the State Insectary," in the Official Report of the Thirty-fourth Fruitgrowers Convention, California, 1908:—"As to the predaceous insects introduced from Australia, their importance in California has been grossly exaggerated. Up to the present time they have not established themselves permanently in more than two counties in the State, and in regions where thousands and tens of thousands have been introduced, they have died out almost completely. Very little of the evidence that is given as to the work of these insects is reliable. Whenever any decrease of black scale is observed, and there is any *Rhizobius ventralis* about, this insect is said to have been cleared by this insect, or, rather, the scale destroyed; it was found that while the scales were dead, there was no sign of an injury such as would have been made by feeding upon it by either the larva or adult of *Rhizobius ventralis*. No reliable observations have been made, and a very large proportion of what is asserted is guesswork. *Rhizobius debilis*, about which so much has been published, and for which so much has been claimed, was not found in California, and there is every reason to believe that the insect has died out entirely. In most cases the common Californian *Scymnus marginicollis* is mistaken for *Rhizobius debilis*, and sometimes for *lophantæ* as well. *Rhyzobius debilis* does not occur in any of the collections in California except in imported specimens. . . . . Perhaps *Orcus chalybeus* should be referred to here, because that is still to be found in small numbers in one orchard not far from Los Angeles. It has not increased, however, since the first year or two, and, on the contrary, seems rather to be dying out, just as *O. australasiæ* did two years previously. Taking everything into consideration, there is nothing that warrants the assertions put forth by the horticulturists of California."

"There is no doubt that the native parasites of scale insects are efficient in keeping down the insects to some extent; but of the sixty species imported by Koebele, in many thousands of specimens there is not one that can be considered a success at the present time. Of course, there is a belief to the contrary, and some superficial evidence to support it; but there is, at least, as much evidence in the opposite direction, and it seems to me that the state of affairs hardly warrants the discontinuance of destructive measures against the injurious insects."

S. A. Pease, of San Bernardino, in his interesting paper previously quoted, read before the Thirty-fourth Fruit-growers' Convention of California, last May, says:—"Since 1893, we have had periodical reports that a perfect

parasite has been introduced that would keep in perfect check widespread pest and life destroyer of fruit and other trees, the black scale, *Lecanium (Saissetia) oleæ*. It was about this time that *Rhizobius ventralis* and *R. debilis*, and *R. tooworabæ* or *lophantæ* were acquired. Those, with the aid of *Tomocera californica* and *Chrysopa californica*, did some splendid work along the coast. Indeed, they made such a good showing that orchardists in the interior had great hopes that they would control the scale everywhere. Hundreds of thousands of them were colonised in every section of the southern orchards, but after repeated trials, and after waiting a number of years for them to be acclimated to our drier and hotter interior climate, we were forced to give them up, and again resort to fumigation and spraying to relieve the orchards."

Speaking further on of the olive scale parasite, *Scutellista cyanea*, introduced from South Africa into California in 1901, he says:—"They increased so rapidly that it was commonly thought that, finally, we had the right enemy for the black scale, and that the pest was doomed. In two years' time I saw in our country orchards where at least 60 per cent. of the black scale was parasitized in the month of August, and I, with the rest, thought that our troubles with the black scale were at an end. The following April I looked for a colony, but could find not find one. The same results had to be recorded for May. In June, I could find a very few, as also in July. In the latter part of August they were very numerous again; but I looked further this time, and I found that while in some instances 60 per cent. of the old scale was parasitised, still from 75 to 90 per cent. of the young scale had hatched out on the leaves and limbs of the trees."

Among the most praised ladybird beetles introduced from Australia, where it is certainly one of our best mealy-bug destroyers, is *Cryptolæmus montrouzieri*, which did good service in Honolulu; yet, in the same report, Mr. Pease says:—"Mealy bugs (*Pseudococcus citri*) bid fair to be a most serious trouble. They have a number of enemies (*Cryptolæmus montrouzieri*), but their control of the insect is only partial, and so not satisfactory."

Professor A. J. Cook, another Californian authority on parasites, speaking at the same fruit-growers' convention, says, after praising both good and doubtful insects:—"We must gas unless our friends are masters of the situation. To wait for the *Scutellista* or golden chalcid until our groves are ruined, or materially injured, by the black or yellow scale is the height of folly. The wise course would seem to be to fight our pests by the best method, unless our enemies are sufficient to keep them down; and in case we do not have efficient parasites or predaceous species, to hunt for them with the keenest vision we can secure."

PART III.

Fruit Flies.

A general account of the flies belonging to the family *Trypetidæ* that damage sound fruit; with descriptions of the different species (some described as new), and their habits, range, and suggestions for destroying them.

The group of insects known as "Fruit Flies," though so much before the public at present, need some definition, for it is a common thing for the orchardist to assume that any small fly hovering round damaged or rotting fruit is the "fruit-fly" and any maggot in the mass to be the destructive fruit-fly maggot. In a great many cases the latter are species that have no connection with the true pests, that never damage sound fruit, and are simply attracted by the decaying matter, and really act as scavengers. The fruit-flies are a well-defined group of the order Diptera (two-winged flies), and belong to the family *Trypetidæ*.

This family comprises a large number of rather small flies, usually with mottled or banded wings; they are remarkable for their curious habits in the larval state in producing galls upon plants, or in mining in the tissue of the stems, leaves, or flowers of different plants, or in the flesh of ripening fruit. The females, with their needle-like ovipositors, puncture the plant and deposit the eggs beneath in the tissue.

In Australia we have a number of indigenous species that form galls; but the group that we are dealing with here are those that have the habit of depositing their eggs in the fruit of wild or cultivated plants, and comprise some of the most serious pests that the orchardist and gardener have to fight against. Some of these are cosmopolitan and are found in many countries, while others are restricted in their range; but whenever a species attacks cultivated fruit it can very easily be introduced into a new country, either in the larval (maggot) or pupal (chrysalis) stage.

Eggs deposited in fruit may be transported in apparently sound fruit and on transit may develop days afterwards, or the more or less developed maggots may reach maturity, crawl out of the fruit, and pupate in a crevice in the case or among the packing, and then after the contents of the case have been destroyed it may develop, emerge as a perfect fly capable of doing untold damage. There are records proving that the pupæ have been found in the soil round the roots of imported plants that have been grown in infested districts.

The destructive species of the family *Trypetidæ* have been described by many entomologists, and are comprised in about half a dozen genera. In the north-eastern States of North America there are two common orchard pests which, originally placed in the genus Trypeta, have, after closer examination, been placed in the genus *Rhagoletis*, a group of small flies with four bristles on the scutellum and black cross bands on the wings. The apple maggot (*Rhagoletis pomonella*), a native of North America, where it fed upon haws and crab apples growing in the forests, is often a very serious apple pest in New York State. When I was at Cornell University, Ithaca, in the early part of October, the apples growing on the College campus were full of maggots. A second species (*R. cerasi*, "The Cherry Fruit Fly") has a similar range in the United States, sometimes causing considerable damage

in the cherry orchards. One or two species are also found in Europe. The genus *Trypeta* contains a number of gall-producing species, but there are also several that have turned their attention to fruit in this genus, of which *Trypeta ludens*, the "orange fly" of Mexico, is a typical example.

The Mediterranean fruit-fly is placed in the genus *Ceratitis*, and represents a world-wide pest. A number of allied species have been described from southern Africa and Mauritius.

Some species have been described and placed in other genera, which, after closer examination by specialists, may be found to belong to some of the above typical groups.

The maggots of the typical species of *Trypetidæ* that infest fruit are so much alike in general form and structure that a general description of one species will define them all. There are a few minor points of difference known to the entomologist such as the shape, number, and situation of the spiracles that are placed on the last segment and surrounded with a rosette-like process.

The maggots vary in colour (according to their food) from semitransparent white to yellow of all shades to pink and red, and the average length of a full-grown one is ½ an inch in length. They can be best described as rather slender, naked, cylindrical grubs, tapering from the broader truncate anal segment to the front of the head (or cephalic segment), which comes to a blunt tip, and contains a pair of black, hard, retractile hooklets or jaws. With the aid of these jaws and with the power of contracting the segments of the body, they can move quickly through the damaged tissue of the fruit, which they tear with these curved jaws; and also, when full grown, can work their way into the soil when they leave the fruit to pupate, and so are very soon out of sight if placed on loose soil. They also have the power, particularly if placed on a smooth surface, of curving the ends of the body round and springing up a considerable height—like the "jumper" maggots in cheese.

They all feed in the same manner, commencing as soon as they hatch from the eggs, to feed upon the surrounding tissue; and in ripe fruit the infested area soon spreads and forms a putrid mass extending to the centre, when the fruit falls to the ground. I do not think that the maggots drop from the hanging fruit, except on rare occasions; but as many of the maggots are not fully developed when the fruit falls, they remain until fully fed before they crawl into the soil beneath.

Their action upon this tissue of different fruits is characteristic, for while in the orange, peach, and soft ripening fruits it all becomes a putrid mass, in unripe peaches it is more a network of damaged tissue in the early stages, and where apples and pears are attacked their mining becomes a series of galleries or small chambers before the final decay.

This is so noticeable in the work of the apple maggot in America (*Ragoletis pomonella*) that it is often called the "railroad maggot." When full grown the maggots crawl out through the underside of the fruit, and thus resting on the soil they work their way downward to a depth of ½ to sometimes 2 inches if the soil is very loose, but usually more will be found less than an inch under the remains of the fruit.

They do not take long to transform from the soft maggot to the oval hard pupa, the outer skin of the maggot changing into a stout shell-like case of yellow or reddish-brown tint. Enclosed in this protective covering, the final transformation to the perfect fly takes place. Then, when ready to emerge, it bursts the front of the shell off and works its way up to the surface of the soil, a perfect fruit-fly.

The habits and life histories of several species have been closely studied by many entomologists during the last twenty years, so that we know the conditions under which we have to work against them. Under ordinary conditions an immense number of eggs never hatch out through want of heat in the early part of winter, and the action of the fly in ovipositing only causes a dull coloured-spot to appear on the skin of the orange, the "sting mark" of the orchardist. In the maggot stage many get exposed and killed, and there must be also a very large percentage of perfect flies that after they emerge from the pupæ cases never reach the surface. We know that in the dry hot seasons fruit-flies are always worse, while after a very wet winter they are never so plentiful. The obvious reason is, that when the orchard soil is sodden and beaten down by rain storms it becomes so hard and caked that any flies from deeply-buried pupæ have a very small chance of getting through to the surface.

In all countries where irrigation is carried out in a systematic manner and the ground flooded in basins round the trees at regular intervals, though the fruit-fly is a well known pest, it comes and goes, and is not constantly in evidence as in Australia and Africa, where conditions are so different. In southern Spain and Sicily this is one of the great factors in the checks upon the increase of fruit-flies.

Among all the pests that have turned their attention to cultivated fruit there is no group so well protected from natural enemies as the fruit-flies. From the time they emerge from the eggs to the time they burrow beneath the fruit into the soil they are feeding and working beyond the reach of many parasites, predaceous insects, and birds that would otherwise feed upon them. Free to a great extent from enemies that reduce the number of other insects, they are also safe from all sprays and contact poisons while doing the damage; sprays will not kill them, and fumigation with gas, so deadly to scale insects, will not affect them. We have, therefore, to resort to different methods in dealing with them. We must either destroy, drive away, or capture the perfect flies before they can lay their eggs, or else destroy the infested fruit containing the eggs and maggots. In every country where action has been taken by the Government to protect the gardener and orchardist against himself or his careless neighbours, this has been recognised, and Fruit-fly Destruction Acts have come into force, in which the main principle has been the inspection of orchards, and the compulsory cleaning-up and destruction of all infested fruit. In Mexico the Department of Fomento obtained a grant of money to be expended in the fruit-fly infested orange orchards of Morelos. The Commission of Parasitologia Agricola, in whose hands the work was placed, formulated the following rules:—

(1) Gather each day all mangoes, lemons, and oranges which may have fallen from the trees, and deposit them in a clean corner of the orchard.

(2) Destroy all fruit so accumulated at least once a-week.

(3) It is preferable to destroy the fruit by burning, but it may be disposed of by burial, and when buried it should be covered with at least fifty centimetres (about 20 inches) of soil.

(4) If the same worm exists in the guava, this fruit should also be destroyed in the same manner.

I have described in my second Progress Report how I saw this work carried out in Mexico by the inspectors at Yutapec.

The only parasite that has been found attacking this fruit-fly is a small red braconid wasp, with a black head and dark-coloured wings, named *Cratocipila rudibunda*. Isaacs states in his report (1905): "The parasite has not as yet done any effective work on the *Trypeta ludens*, as investigations have shown that not over 10 to 15 per cent. of the maggots are parasitised. Every effort is being made to encourage the propagation of the parasite, and great hopes are entertained that it may yet overtake the plague and keep it in check."

Koebele, who gave me specimens of this parasite he had bred from mangoes obtained in the Mexican markets, told me he had never bred it from infested oranges. Professor A. L. Herrera, the Chief of the Entomological Staff at Mexico City, informed me that the parasites had made no difference to the pest up to the time of my visit (October, 1907).

In consequence of the presence of this fly in Mexican orchards, the State Board of Horticulture prohibited the importation of Mexican oranges into the State, and the railways running between the two States refused them as freight. Mr. Craw caused all cars used for transportation of Mexican oranges to be disinfected with steam before they could be again used in California.

In Bermuda an Act on very similar lines came into law only last year, and has, according to Mr. Harris, already made a marked difference in the numbers and damage caused by their fruit-fly pest.

There are no special laws in the southern countries of Europe and northern Africa against fruit-flies, but in all countries where these pests are known, all the entomologists have urged the orchardists to destroy as much as they can of the infested fruit.

In the Turkish village of Lefka, in Cyprus, where a large quantity of oranges are grown, I found no traces of fruit-flies, probably because every fallen fruit was eaten clean out of the skin by rats.

Besides the destruction of the maggots in the fruit, we can also destroy many of the adult flies, on account of their liking for certain oils. It was discovered about two years ago in Western Australia that if a dish containing kerosene was placed out in an orchard, the Mediterranean fruit-fly was attracted by the scent and flew into the oil. This was confirmed when suitable tins were placed among infested trees, for thousands were taken in a few days; and wherever tried it has had the same effect upon this species. This oil, however, had no charms for the Queensland fruit-fly when it was tried in Queensland. While experimenting in the orchards of India, where a species closely allied to the Queensland fly was very abundant, Mr. Howlett discovered that citronella oil spread on some leaves, on a stone, or smeared upon a handkerchief, attracted this and an allied species, but had no attractions for a third larger species that destroyed the melons and gourds. I took a thousand specimens of this fruit-fly (*Dacus ferrugineus*) with half-a-dozen sweeps of my net over some leaves upon which we had placed oil the previous evening. One remarkable thing was that when we came to examine them we found that all the specimens were males. Further experiments right through the season should prove whether this is always the case; but even so, the destruction of all the males would soon lead to infertile females. If other oil can be found to attract other species, they can be mixed with poison or used in traps, and will become a very effective aid in controlling the pest.

The Olive Fly (*Dacus oleæ*) is one of the most serious insect pests in the world at the present time, for last year it destroyed so large a percentage of the olive crop that it was estimated that the loss in olive oil due to the

damage by the olive fly totalled £1,000,000. In dealing with this pest, a very large reward is offered by the Italian Government for any remedy or method to check the pest.

Professor Berlese, the celebrated Italian zoologist, stationed at Florence, has experimented with a sweet poisoned spray, consisting of honey, treacle, arsenic, and water. The formula is—

Mellasa (in English molasses)	40
Miele (honey)	40
Arsenate of potassi	2
Aqua (water)	18

The spraying of the trees was very successful in the experiments carried out except that it was very easily washed off, and also that in some instances a number of bees were killed.

The Professor is now experimenting with a similar mixture placed in small bottles hung up on the branches of the trees. Into each bottle is inserted several long cotton threads, forming loose bundles hanging several feet, down which the poisoned liquid flows, and the flies find a ready resting-place while they sip the poison.

I have written to Professor Berlese, and asked him to try the addition of citronella oil to his poisoned mixture, which he calls Dacacide, and to let me know whether it attracts the olive fly. His assistant informed me, when at his laboratories in Florence, that the majority of the flies killed with Dacacide were males.

In South Africa, where fruit-flies are probably as bad as any place in the world, fine netting was used to protect the fruit on the trees from the flies, but it was so expensive on a large scale that its use was not extended, and it was only when there was a very valuable crop that it paid.

Where the orchard is kept in good condition, domestic poultry, particularly hens which have the scratching habit highly developed, no doubt, if given the run of the orchard, will unearth a lot of pupæ and destroy many in all stages of growth.

Family—*Trypetidæ*.

All the members of the true fruit-flies are placed in this family of the Diptera, and are classified by most authorities as a division or group known as the *Muscidæ*, which it is not necessary to define here.

Williston in his "North American Diptera" (second edition), 1896, gives the following definition :—

"Head hemispherical; face nearly perpendicular in profile, or somewhat retreating, without distinct vibrissæ; front broad, bristly on the sides, the lower fronto-orbital bristles situated close to the border of the eyes; antennæ decumbent, short, rarely elongated; abdomen, composed of four or five segments; genitalia of the males but little exposed; the ovipositor jointed, more or less projecting; wings rather large; auxiliary vein present, ending steeply and obscurely in or near the border; posterior basal cell and the anal cell distinct, the latter often drawn out into an acute, often prolonged, point; wings usually with dark markings; legs moderately long; tibiæ without preapical bristle; proboscis moderately long, usually with broad labella, sometimes long, and the narrow labella folding backward."

The family contains a number of small flies, many of which have curiously mottled wings. Some of them produce galls upon plants; the larvæ of others mine in the plant tissue without producing galls; and many are very destructive pests to fruit. They are well represented in Australia by a number of indigenous species, some of which produce galls, such as *Tephritis*, sp., which forms large galls upon the twigs of the Snow Bush (*Aster ramulosa*), and the fruit-damaging species by *Dacus tryoni*, a serious pest to citrus fruits and bananas.

There are a number of different genera in this family that include fruit-flies. The genus Dacus contains a great number of destructive species.

The genus *Ceratitis*, though limited in number of species, comprises several very destructive species, and in the genus *Trypeta* two species are known to attack sound fruit. The genus *Carpomyia* contains the Baluchiston Melon Fly, which appears to come very close to the genus *Ceratitis*. The genus *Anastrepha*, founded by Schiner ("Reise der Novara Zool. Diptera," 262, 1868) for the reception of two South American flies, *Anastrepha munda* and *A. striata*, now includes others that were originally described in the genus Dacus, the common fruit-pest of Brazil. "The Bahia Fruit Fly," *Anastrepha fraterculs*, was named *Dacus fraterculus* by Wiedemann. Another common fruit-pest in the same country, *A. serpentina*, was also first known as *Dacus serpentinus*.

Bigot placed one of the commonest Indian fruit-flies in the genus *Rivellia*. It was found infesting peaches, so he called it *R. persicæ*. It is a Dacus, and I have returned it to that genus in my notes.

Other species that have been described in the genus *Dasyneura* are now placed in the genus Dacus. The generic name Dasyneura having been used by Rondani in 1840 for a group of the Cecidomyia (gall gnats), Saunders' genus created in 1841 will have to drop out of the *Trypetidæ*. The "apple maggot" of the United States, once known as *Trypeta pomonella*, has now been placed in the genus *Rhagoletes*, and the allied species *Ortulis cerasi*, attacking cherries, has come under the same group.

Genus—Dacus.

(Meigen System Beuchr. VI, 22, 1, 1830. Syn. *Musca*, Fabr. Rossi. *Oscinis*, Latr. Fabr., *Brachyopa*, Meig.)

The members of this genus are all rather small reddish-brown flies, sometimes marked with black on the dorsal surface, and in most cases marked with pale or bright yellow nude areas on the shoulders, sides of the thorax, or forming regular stripes or lines on the dorsal surface of the thorax. The scutellum is also often yellow, prominent, usually smooth and shining. The wings are hyaline, often striped or clouded with brown, or blackish. They are active little flies; the shape of the abdomen, narrow and constricted at its junction with the thorax, giving them a wasp-like appearance. When running about over the fruit or foliage, they often carry their wings in a very characteristic manner, drooping down on the sides of the body. They all have the same habit of puncturing ripening fruit, and depositing their eggs beneath the skin of the fruit, the maggots feeding upon the tissue.

These maggots are elongate cylindrical grubs, and pupate in the soil upon which the damaged fruit falls.

The members of this genus have a very wide range through Africa, India, the Malay Archipelago, Australia, and some of the Pacific Islands; a few have been described from South America; and one, the olive fly, has a wide range over the Mediterranean region of southern Europe.

The Queensland Fruit Fly.

(Pl. I, fig. 1, and Pl. VI.)

Dacus tryoni, Froggatt.

(*Tephrites tryoni, Agricultural Gazette of New South Wales*, June, 1897, p. 410, pl. 8, fig. 1. Miscellaneous publications, No. 163, 1897, Dep. Agriculture N.S.W. (reprint). *Agr. Gaz. N. S. W.*, June, 1899. Reprint Misc. Pub. 303, Dep. Agr.)

Though the maggot of this fruit-fly had been known for many years in Queensland and New South Wales (it is stated as far back as 1852) as a pest to fruit-growers, it was not identified until Tryon published his admirable observations on economic entomology ("Report on Insect and Fungus Pests, No. 1, 1889," for the Queensland Government). He identified it as the larva of a dipterous insect of the family Trypetidæ and though he did not give it a specific name, placed it in the genus *Tephritis*, under which genus I placed it when giving it specific rank under the name of *Tephritis tryoni*, in recognition of Mr. Tryon's valuable investigations into its life history and habits, contained in the above report. At this time in southern Queensland it was recognised more as a peach and nectarine pest from a commercial point of view, though it had been bred from nearly every kind of fruit except grapes and passion-fruit.

Since Tryon wrote, this fruit-fly has become a very much more serious pest, probably partly from the extension, particularly of banana orchards, into the northern parts of his State, and also from the growth of the interstate fruit export trade. During the last ten years the interstate export and import fruit regulations and Vegetation Diseases Acts have come into force, and much more attention has been called to this fruit pest from the natural anxiety of the southern States to keep it out of their orchards and to protect their fruit-growers.

From observations extending over a number of years, it seems fairly evident that the natural or permanent southern limit of the Queensland fruit-fly is about Gosford, in the rich brushes that extend within 50 miles of Sydney. We often get this species much nearer Sydney, but it is an accidental or isolated case of infestation that can be readily traced; and unlike the more cosmopolitan Mediterranean fruit-fly, I do not think that *Dacus tryoni* will ever thrive and become a fruit-pest south of Sydney. In all the years that bananas have been imported (for years without any restrictions), it has had every chance of getting all over Tasmania, Victoria, and South Australia, but it has never taken hold of any district south of Sydney.

A great number of general reports have been written and compiled by our economic entomologists on this species, but no fresh conclusions have been arrived at regarding the best means of checking its ravages. Though several hymenopterous parasites have been bred from the pupæ, they have no effect upon the increase of the pest on account of their rarity, and can only be regarded as interesting from an entomological point of view.

Description: Length, 3 lines; expanse of wings, 5 to 6 lines. The perfect fly has clear transparent wings, clouded very slightly, clouded along the costal nervure, and a fine transverse fuscous stripe crosses the wing towards the base; the nervures reddish. The abdomen, constricted at the base, is broadly rounded to the tip, furnished with a fine ovipositor in the female, while that of the male is more elongated, so that the female is more wasp like in form than the male.

In general coloration they are somewhat variable, but on careful examination the yellow markings will be found constant; but this has led to some confusion in determining the species, when they have been bred from uncommon fruits or vegetables. Head: The eyes almost black; face, with rounded black spot on either side below the antennæ; tips of antennæ fuscous, and a few indistinct spots or marks on the forehead; thorax, with a broad creamy often pale dorsal band, running down to the scutellum; with a short, well-defined narrow pale yellow stripe on either side. On the sides of the thorax there is a small, rounded, creamy white spot in front, with a blotch formed of two parts of the same colour in a line with the front of the parallel side stripe; the scutellum, white to pale yellow, is prominent, somewhat convex on the upper surface, broadly angulated behind, with two stout bristles. The legs are pale yellow, tarsi darkest; abdomen, blackish to brown, with a broad transverse band of pale dull yellow across the basal half. The bristles on the antennæ are long, with fine scattered bristles on the head and sides of the thorax, and the abdomen finely pubescent.

It is, in the first place, a typical orange fly, then a banana pest; but there are few fruits that it has not been bred from at some time or other. It is closely allied to the Indian Mango Fly, *Dacus ferrugineus*, described by Fabricius, and ranges from India and Ceylon to Java and Amboina. Though commonly a mango pest, it attacks and destroys many fruits.

In the *Journal of Agriculture*, Victoria, May, 1907, French published an article entitled "Fruit Flies," afterwards issued as Bulletin 26 of the Department of Agriculture, Victoria. In this paper he describes a variety of *D. tryoni* under a varietal name of *Dacus cucumis*, the maggots of which were obtained in large quantities from cucumbers imported from Queensland. I have carefully compared specimens kindly given to me by Mr. French, and others that we have bred from cucumbers that were sent from Coonamble, New South Wales, and consider it may rank as a species. There are no differences in the wings, but the whole insect is of a much lighter colour, and has a well-defined short, broad, pale yellow blotch or stripe in the centre of the lower half of the dorsal surface of the thorax, while the side stripes of yellow on either side are shorter, broader, and more curved.

There is, apparently, another variety, if not a distinct species, that breeds in tomatoes grown in Queensland.

Another variety, also found breeding in tomatoes from Queensland, has two well-defined blackish parallel lines down the sides of the dorsal surface of the thorax, which run into each other behind the head, with the silvery pubescence enclosed between them.

At the same time, I have typical specimens of the Queensland fruit-fly without the central yellow blotch, also bred from tomatoes.

Probably other members of this genus will be found in the northern portion of Australia, when carefully looked for, as the genus has a wide range.

The Mango Fruit Fly.

(Pl. II, fig. 8.)

Dacus ferrugineus, Fabricius.

(Ent. Syst. IV, 342, 127; Fab. Syst. Antl., 274–5; Wiedemann Aussereuropaische Zweifluegelige Insecten, 1828–30, vol. II, p. 515; Macquart, Dipteres Exotiques, nouveaux ou peu connus, 1838, Supp., 3, 64, and 4, 2.).

Doleschall described this species under two different names; first as *Bactrocera maculipennis*, in the Natuurk Tijdschr van Nederl, Indie, vol. X, 1856, p. 36, and figured it on plate 1. In the same journal, two years later, he described a variety under the name of *Bactrocera conformis*. Van der Wulp notices this in the Annales de la Societé Entom. de Belgique, in 1884, in a paper entitled "Quelques Diptires Exotiques."

In "Indian Museum Notes," vol. III, 1896, in a contribution called "Miscellaneous Notes," E. C. Cotes figures and describes this fly as a mango pest in India; and though he states that specimens sent to the British Museum had been identified as *Dacus ferrugineus*, Fab., he calls it var. *mangifera*, Cotes, under which name are specimens now in the Calcutta Museum.

Originally described from Java and Amboina, it probably has a wide range, and is certainly one of the commonest species in India and Ceylon. If my determination is right, it is in regards to coloration and size a very variable species, running from black in the thorax, and even the body, to reddish-brown. This is one of the two species that is attracted by the scent of citronella oil, the other being *Dacus diversus*.

It is a general fruit pest, breeding from mangoes, oranges, and other fruits; but they were not obtained from any of the Cucurbitæ, nor were they bred from the infested peaches in the Government orchard at Pusa. This is a smaller reddish fly, which agrees with Bigot's description of *Dacus persicæ*.

Dacus ferrugineus is a medium sized species, measuring from 7 to 5 mm.; it is of a general rusty red colour, with the dorsal surface of the thorax varying from black to a uniform rusty red tint; sometimes the abdomen is marked with almost black bands. It has the shoulders, blotches on the sides, and two lateral stripes on the dorsal surface of the thorax of pale, but often bright yellow; and the scutellum is also of the same colour. The wings are hyaline, with reddish nervures, and the only marking upon them are a reddish stripe along the latter half of the costal nervure, a very faint mark of fuscous at the extreme tip of the wing, and a blotch along the anal cell. The legs of the female are blotched with brown; those of the males lighter. The abdomen has a narrow and then a much wider transverse band round the basal half of the body, with a narrow dark parallel stripe down the centre of the apical half, with either side darkly blotched; the tip ferruginous. In the darkest varieties the central bar does not show, as the whole of the lower portion of the abdomen is dark reddish-brown to almost black.

There is a specimen in the Verrall Collection, determined by Bigot as this species, from Java.

Maxwell-Lefroy has figured this fly in his "Important Insects injurious to Indian Agriculture" (page 227, vol. I, No. 2, 1907).

The Peach Fruit Fly.

(Pl. II, fig. 5.)

Dacus persicæ, Bigot.

(*Rivellia persicæ*, Bigot, Indian Museum Notes, vol. I, p. 192, 1889. E. C. Cotes, *l.c.*, p. 195.)

"The fly here described certainly belongs to the family Ortalidæ, by the neuration of the wings. It seems to me identical with the genus *Rivellia*, Desv., following the classification of Rondani (Bull. del Soc. Entom. Italia, Firenze, 1869); and it ought to be included in the large genus *Dacus* of Fabricius (Macquart, Dipt. de Europe et exotique).

"The specimens examined ($\begin{smallmatrix}\uparrow\\ \circ\end{smallmatrix}$ and $\begin{smallmatrix}\circ\\ +\end{smallmatrix}$) were damaged, and in such bad condition that their description may not be quite exact. As this species appears to me to be new, I propose for it the name of *Rivellia persicæ*.

"Male and female. Length, 7 mm., the ovipositor projecting.

"Antennæ dull yellow, with the extremities blackish; palpi pale yellow; head and face reddish; angles of the sides blackish, with two light lines on the inner margin of the eyes; clypeus reddish, with two large, longitudinal bands, somewhat indistinct, with a greyish-brown pubescence; shoulders, two narrow lateral lines, pale yellow; scutellum greyish-yellow. Abdomen reddish, with a narrow dorsal line, black, indistinct anteriorly; ovipositor depressed, angular at the extremity, yellowish, the rest of a light yellow to dark brown; legs yellow; the posterior tibia brownish at the base and extremities; tarsi white; wings hyaline, the longitudinal nervures clouded with yellow at the base; stigma pale yellow. The wing is marked with a a small, blackish patch, situated at the extremity between the costal nervure and the third longitudinal nervure (of Rondani)."

The above is a translation of Bigot's description of the fruit-fly which was sent to him from Chota Nagpur, India, by E. C. Cotes, the Director of the Calcutta Museum. They were bred from maggots that were very destructive to peaches grown in that district, from which habit Bigot gave it the specific name *persicæ*.

Mr. Irvine, who collected the specimens, sent some interesting notes. He says: "To stop the injury or ameliorate the harm done, I intend trying the effect of removing at least 6 inches of the soil from under the trees during the cold weather, and thoroughly baking the same, which must kill all there is in the soil of insect life. I would further recommend the instant removal of all pierced fruits which fall to the ground, and the burning of the same, or else placing them in a trough of water for at least twenty-four hours.

"Whether the millions of larvæ that have pupated in the soil during the peach-crop season, when hundreds of decaying fruit fell to the ground, have since taken wing, or remain to hibernate in the soil till next season's crop, is a problem to solve."

When working in conjunction with Mr. Howlett I obtained many specimens of this species on the wing among the melon patches at Pusa, near the Imperial Research Laboratories; and this was one of the two species that was attracted, both there and at Bangalore, by the scent of the citronella oil. In the peach orchard attached to the station at Pusa nearly every peach in the orchard was infested and thousands of fine fruit were lying under the trees, full of maggots.

This is the small, reddish fruit-fly in which the nude areas on the shoulders sides of thorax, and scutellum are so pale that they might be called white with a narrow, pale stripe of the same colour on either side of the thorax, above the base of the wings.

The Three-striped Fruit Fly.

Dacus diversus, Coquillet.

(Proc. Ent. Soc. Washington, vol. VI, No. 3, pp. 139, 140, 1904.)

"Head and its appendages yellow, base of proboscis brownish; face of the male unmarked, that of the female with a transverse black fascia a short distance above the oral border, front with a central brown spot, and a row of three brown dots along each eye; vertex with a narrow black fascia produced forward in the middle, so as to include the lowest ocellus; occiput with a brown vitta on either side of the centre, the two connected at their upper ends by a brown fascia; antennæ slightly longer than the face; arista bare. Body black, the following markings yellow: humeral callosities, a short streak in centre of mesonotum, a vitta situated a short distance above each lateral margin of the mesonotum, extending from the suture to the hind margin; a fascia extending from the front of each of these vittæ to the upper part of the sternopleura; the prosternum largely, the scutellum, a large spot on either side of the metanotum, and including the hypopleura, the hind margins of the abdominal segments, a very narrow on the fourth, and the base of the ovipositor; mesonotum with a median pair of grey pruinose vittæ, which extend from the front end to a short distance beyond the suture; abdomen devoid of black bristles and of long black hairs; ovipositor depressed, slightly longer than the fourth and fifth abdominal segments taken together. Legs of male almost wholly yellow, those of the female yellow, the apices of the femora and whole of the tibiæ black, apices of tarsi brownish. Wings hyaline, base of the marginal cell brownish, costa narrowly bordered with brown from apex to auxiliary vein to a point midway between apices of the third and fourth veins, scarcely widening in its apical portion, anal cell filled with brown, which colour encroaches somewhat on the third posterior cell. Length, 4 to 5 mm.

"Habitat, Colombo, Ceylon, and Bangalore, India."

He had a series of five male and three female flies, that were bred from maggots infesting oranges.

This is one of the species that Mr. Howlett and I collected at Pusa flying about the melon patches, and again at Bangalore in several mango plantations; and though a few were attracted by the citronella oil, most of them were caught on the wing.

It appears to be a very distinct species, differing from *Dacus ferrugineus* in being somewhat smaller in size, and has white or pale yellow line down the centre of the thorax, and the darker and more regular coloration of the abdomen. It differs from *Dacus persicæ* in being larger, and with the black thorax and dorsal stripe on the thorax. The three flies enumerated seem to be the three common species of fruit-flies that infest mangoes, oranges, guavas, and peaches, and have very similar habits, so that they may be checked and destroyed in the same manner.

The Melon or Bitter Gourd Fruit Fly.

(Pl. II, figs. 6 and 7.)

Dacus cucurbitæ, Coquillet.

(*Entomological News*, May, 1899, pp. 129, 130.)

The specimens, from which this species was described, were bred from cucumbers in Hawaii, where it is a common and very destructive pest to watermelons, musk melons, cucumbers, tomatoes, and string beans; but it has never been bred from fruit. At the time it was described its native home was unknown, but subsequently Mr. Muir, of the Sugar Planters' Association laboratories, found that India was its original home; and my investigations, later on, showed that it was the common Bitter Gourd or Melon Fly, widely distributed over India and Ceylon.

One of my first investigations in Hawaii was in connection with this pest, and, accompanied by Mr. Van Dine, of the United States Experiment Station, who has written a very concise bulletin, "The Melon Fly," published in *The Hawaiian Forestry and Agriculturist* (April, 1906, vol. III, p. 127), I spent several days in the fields and among the melon-growers. Melons are grown under irrigation in large quantities on the rich black soil of Makaha, about 35 miles from Honolulu, where, at Holt's ranch, I obtained many specimens. The work is carried out by Chinese and Japs on the share system, or they rent the land from the owner. The ordinary watermelon, being harder, is not so subject to infestation, after it has reached the size of a hen's egg, as the cantaloupes (rock melons); but as soon as the melon is set, the cultivators place them in paper bags, and thus protect them from the flies, leaving them on the soft-skinned cantaloupes until they are ripe. In consequence of the great rise in price of all kinds of melons since the advent of the fly, the growers, under the new methods, may make almost as much money as they did before, but the consumer has often to pay 50 cents for what he used to pay only 10 cents in the old days.

Where numerous the flies, probably accidentally, puncture the melon stems, and the resulting maggots destroy the tissue, causing much of it to die. Many of the small melons infested were found to be completely hollowed out, and were just a mass of semi-dry pith and maggots, ready to work through the skin and pupate in the ground beneath. Some we found nearly 2 inches below the surface. We found hardly a fly at midday in the melon fields, but on examining the weeds and turnip plants forming a border along the irrigation channels, we found them in numbers resting among the green foliage.

At Molokai Island we found some of the growers covering their melon and cucumber beds with cheese cloth, but though it kept the flies out, it also kept all the bees and small insects that, under ordinary conditions, fertilize the flowers, so that very few melons ever set and matured.

In spite of the destruction caused by the fruit-flies, with the use of paper bags, Mr. Holt and his Asiatic partners were shipping 800 melons per week to Honolulu, where they brought from 30 to 50 cents a-piece, the picked ones from 75 to 1 dollar each. He works on the halves system, finds the land, quarters, and a mule to cultivate, the men doing all the field work, while he attends to the shipping and sale of the produce.

Later on, in the vegetable gardens on the slopes of Mount Tantillus, we found the fruit-fly maggots in many ripening tomatoes and string beans.

There are no laws or regulations dealing with the destruction of damaged fruit in Hawaii. No parasites have been bred from the many pupæ and larvæ under observation in the Entomological Branch of the United States Experimental Station.

Melon Fly in India and Ceylon.—One of the first species of fruit-fly that I found in India was *Dacus cucurbitæ*, and wherever we examined melon gardens in Central or North-Western India, we noticed this fly hovering about, and we bred it from maggot infested melons, cucumbers, bitter gourds, and egg plants. One remarkable thing about this species was, that while Mr. Howlett and I could attract thousands of the two smaller fruit-flies with a handkerchief moistened with citronella oil, we never had a single specimen of this fly come to the bait.

This species, though well known in India, and represented in most of the museum collections, had not been named, or, at any rate, identified, until Coquillet named "A new Trypetid from Hawaii."

In the northern part of Ceylon, at Jaffna, I found many damaged melons containing fruit-fly maggots, and, later on, bred this species from the pupæ.

Dacus cucurbitæ is one of the larger species of the genus, and can be easily recognised by the mottled wings, the brown tints forming a band along the front margin, and two more or less regular transverse markings on the hind portion.

Herewith is Coquillet's original description.

Dacus cucurbitæ.—Head light yellow; the occiput, except the sides and upper margin, reddish-yellow, an ocellar black dot, front marked with a brown spot in front of its centre, and with three pairs of orbital brown dots, a black spot on each side of the face near the middle, and a brown spot on the middle of each cheek; antennæ, palpi, and proboscis yellow, the latter mottled with brown; thorax, reddish-yellow, the humeri, a median vitta on the posterior half of the mesonotum, another on each side, above the insertion of the wings, uniting with an irregular band which extends upon the pleura to the upper part of the sternopleura, also a large spot on each side of the metanotum, encroaching upon the hypopleura, light yellow; scutellum, except its extreme base, light yellow, bearing two bristles; abdomen light yellow on first two segments, reddish-yellow on the others, the extreme base, a fascia at the bases of the second and third segments, usually a lateral spot on the fourth and fifth, also a dorsal vitta on the last three segments, blackish or brownish; first segment of the ovipositor of the female slightly longer than the fifth segment of the abdomen. Wings hyaline, the apex of the subcostal cell, from a short distance in front of the apex of the auxillary vein, the marginal and submarginal cells, the median third of the first basal cell, and a large spot in upper outer corner of the first posterior cell, brown, this colour encroaching on the third posterior cell and bordering the sixth vein almost to its apex; posterior cross vein bordered with brown, this colour extending to the hind margin of the wing; upper end of the small cross vein is also bordered with brown. Halteres light yellow. Legs light yellow, the broad apices of the femora and the last four joints of the tarsi reddish-yellow; hind tibiæ reddish-yellow or dark brown. Length, 6 to 8 mm. Type, No. 4,207 in the United States National Museum.

The South Sea Guava Fly.

(Pl. VII, figs. 1a, 2a, 3a)

Dacus psidii, Froggatt.

(*Tephritis psidii*, Froggatt, *Agricultural Gazette, N.S.W.*, 1899, p. 501, Pl. ii, figs. 1*a*, 2*a*, 3*a*. Miscellaneous Publications, Dep. Agr. N.S.W., No. 303.)

In the original description the numbers of the plate are transposed, but on reference to the letterpress the mistake will be noticed. The larvæ were obtained from infested guavas condemned in a shipment of fruit from Noumea, New Caledonia. Specimens were afterwards obtained from granadillas that came in a similar condition from Fiji.

In general appearance, the maggots which were kept under observation did not differ from those of *D. tryoni*, and they pupated in the soil in the breeding-jars just beneath the surface. This is a medium-sized species, measuring three lines in length and about five across the expanded wings. The head light brown, with rich metallic purple eyes; antennæ brownish-yellow, the last joint black, long and cylindrical, finely pubescent, the bristle stout and long, with scattered bristles on the face and hind margin of the head; thorax black, with a few fine bristles near the base of the wings, a broad parallel white stripe down the centre, with a pale yellow stripe down either side, the humeri a stripe on the sides marked with creamy white; the scutellum large, angular, broadest in front, so broadly margined with creamy white that the centre forms a black triangle, a pair of black bristles ornamenting the hind margin; legs brownish-yellow, clothed with fine hairs, tarsal spines and claws black; the wings hyaline, very slightly clouded at the tips; nervures blackish; the transverse cubital nervure clouded on either side with black, giving it a thickened appearance; the apical portion of the second costal, the base of the third costal, and the third basal cell clouded with brown; the abdomen black, elongate, narrow at base, pointed to extremity; the genitalia ochreous; ovipositor consisting of a stout horny pointed process, enclosed in a pale yellow sheath of a granulated structure.

Habitat, New Caledonia and Fiji.

Dacus longicornis, Wiedemann.

(Aussereuropaische Zweiflugelige Insecten, vol. II, p. 524, 16.)

This species was described from Java, but I have a specimen obtained in India, so that it probably has a wide range. There is a specimen in Verrall's Collection under this name that was probably identified by Bigot.

This is one of the large typical forms of the species, with very long antennæ, a rather stalked pyriform abdomen, broadly rounded at the extremity. It is of a uniform ferruginous tint, with the dorsal surface and sides of the apical half of the abdomen clothed with fine golden pubescence. The wings are hyaline, with a broad well-defined stripe along the costal nervure.

Wiedemann says: "Reddish, constricted at the base of abdomen, costal edge of wings brown. Length, 4 lines." Java.

Dacus lounsburyii, Coquillet.

(Pl. III, fig. 13.)

("Proceedings U.S. National Museum," vol. XXIV, No. 1,243, p. 27, 1901.)

In a paper entitled "New Diptera from Southern Africa," D. W. Coquillet described four new species of the genus *Dacus* from specimens brought from Cape Colony by C. P. Lounsbury, the Government Entomologist, when he visited Washington.

Dacus lounsburyii.—"Head yellow, occiput, except the upper and lateral margins, reddish-brown, frontal vitta, except its lower end, reddish-brown, an ocellar spot, one near centre of front and one on the lanule, blackish, a row of four blackish dots along each orbit; a broad reddish stripe in middle of face, a black spot on either side near its middle, an oblique reddish line near each orbit, and a large black spot below each eye; antennæ nearly twice as long as the head, brownish-red, the extreme base yellow, the third joint black; palpi and proboscis brownish-red, apex of the latter largely yellow; body reddish-brown, indistinctly marked with blackish, mesonotum marked behind the suture with three yellow vittæ, a yellow fascia extends along the suture, crosses the mesopleura and encroaches on the sternopleura; a spot on the hypopleura, hind margins of the scutellum and of the second abdominal segment laterally yellow; abdomen three times as long as wide; the third segment in the male bearing a row of black bristles, extending from the venter half way to the middle of the dorsum, situated a short distance in front of the hind margin; wings hyaline, a brownish band along the costa, filling apex of subcostal cell beyond auxiliary vein, the whole of the marginal and submarginal cells, apical three-fourths of the first posterior and upper edge of the second posterior cell, faintest in basal portion of submarginal cell and darkest in the posterior cells, that in the first posterior cell sometimes having a subhyaline median streak; anal cell filled with yellow and brown, its lobe and the vein extending beyond its apex bordered with brown; base of the first basal cell to forking of second and third veins yellowish; legs yellowish-brown, first tarsal joint, except apex and broad bases of hind femora, white; halteres, whitish; bases of the stems reddish-brown; basal segment of ovipositor of female greatly flattened, shorter than the preceding abdominal segment; length 11 mm.

Described from three males and seven female specimens; the type in the United States National Museum (Catalogue No. 5,786).

Specimens taken at Cape Town and Wynberg, South Africa.

This is one of the largest species of the genus, and is allied to the Australian species *Dacus æqualis*, described by Coquillet, in the Proceedings of the Linnæan Society of New South Wales, and *Dacus longicornis*, Wied., from India and Java.

All of these have long antennæ, are of a general ferruginous tint with few yellow markings, the hyaline wings are clouded along the costal nervure, and the large body is pyriform or turbinate with the extremity broadly rounded.

Dacus brevis, Coquillet.

("Proceedings of the U.S. National Museum," vol. XXIV, No. 1,243, p. 28, 1901.)

Head yellow, frontal vittæ sometimes tinged in places with reddish-yellow, the occiput, except along the eyes, yellowish-brown, a dark brown spot above the centre of front, a small black spot on the ocelli, three along

each orbit, one on the frontal lunule and one on either side of centre of face, a brown spot below each eye; antennae shorter than the head, yellowish-brown, becoming dark brown at the apex, arista black, the base yellowish, proboscis and palpi brownish-yellow; body reddish-brown, mesonotum and abdomen with a mediodorsal black line, and sometimes with blackish markings; humeri, a stripe along the thoracic suture crossing the mesopleura and encroaching on the sternopleura, a rounded spot on the hypopleura, and the scutellum, except its extreme base, yellow; abdomen one and a half times as long as wide, the third segment in the male bearing a row of black bristles extending from the venter nearly half way to the middle of the dorsum; wings hyaline, the subcostal and marginal cells, base and usually the very narrow edge of the submarginal cell beyond apex of the marginal about half way to tip of third vein, where it expands and fills the entire apical portion of this cell and encroaches on the first posterior cell, brown, a brown cloud on distal part of anal cell; apex of fourth vein, not or very slightly approaching toward the third vein; legs yellow, apices and middle and hind femora and bases of middle tibiæ yellowish-brown, hind tibiæ largely, and last four joints of all the tarsi reddish-brown; tibiæ and apices of femora sometimes yellowish-red; halteres yellow; ovipositor of female almost cylindrical, the basal segment shorter than the last abdominal segment. Length, 5·5 to 6·5 mm. Described from two male and four female specimens. Type, U.S. National Museum, Washington (No. 5,787). Bathurst, Cape Colony, South Africa.

Dacus immaculatus, Coquillet.

(Proceedings of the U.S. National Museum, Vol. XXIV, No. 1,243, p. 29, 1901.)

"Differs from *brevis* as follows:—The spot above centre of front scarcely darker than the reddish-yellow frontal vitta, no black spots on the face, bases of palpi pale yellow, yellow spot on each hypopleura nearly twice as long as wide, brown in marginal cell, not connected with that in apex of the submarginal, the latter extending one-third of distance from apex of third vein to apex of second, ovipositor of female greatly flattened, legs yellow. Length, 5 to 6·5 mm. Four males and four females." Collected at East London, Cape Colony, Africa. Type in U.S. National Museum, No. 5,789.

NOTE.—I have received a co-type of this handsome little fruit-fly from Mr. Lounsbury, and add the following:—The eyes dark, the yellow markings on the thorax very bright coloured, scutellum elongate slightly arcuate in front; the dorsal black stripe down the centre of the thorax broadest behind, nearly wedge shaped, apex of thorax below scutellum black; abdomen dark reddish-brown, with the centre crossed with a black band or bar that swells down on either side, forming an irregular oval black patch merging into the bar.

Dacus sigmoides, Coquillet.

(Proceedings of the U.S. National Museum, Vol. XXIV, No. 1,243, p. 29, 1906.)

"Differs from the above description of *brevis* only as follows:—The dark brown spot above centre of front is connected with the upper two spots in each of the orbital rows, no brown spot below each eye, no mediodorsal black line on the abdomen, apical section of fourth vein strongly bisinuous, the apex strongly approaching towards the third vein; legs yellow, the apices of

the femora, bases of the tibiæ and last four joints of the tarsi slightly darker, more brownish-yellow, knob of halteres yellowish-brown, ovipositor greatly flattened, the basal segment one and one-fourth times as long as the last abdominal segment. Length, 7 mm." Described from one female specimen. Found in the Island of Mauritius, Africa. Type, U.S. National Museum, No. 5,788.

The Sudan Fruit Fly.

Dacus, sp.

(Theobald—Second Report of the Wellcome Research Laboratories, Gordon Memorial College, Khartoum, 1906.)

On page 93 Theobald, in his "Report on Economic Entomology," figures and gives a general description of a fruit-fly belonging to this genus that is common in the Sudan, where it is a serious trouble to the melon growers of that part of Africa. He says: "This species comes very near Froggatt's species (*Dacus tryoni*), the Queensland maggot-fly, but is quite distinct."

His description is as follows:—"The Sudan melon fly is somewhat wasp-like in general appearance. The head is yellowish between the eyes, which are large and dark, there is a dark spot on the occiput and two oval black spots on the face below the antennæ, which are yellow with dark apex; the arista is simple. The thorax is slaty-grey, with minute dark brown specks, and fine, pale, backwardly-directed short hairs, a bright nude yellow area at each shoulder, a yellow nude plate on each side in front of the base of each wing, which passes a narrow, wedge-shaped area into the median transverse suture, the lower area of the spot is formed on the pleuræ, and there is a smaller one below and another on the pleuræ just behind the wings; the scutellum is yellow and nude, and the metanotum deep slaty-grey.

"The abdomen is much contracted basally and acute apically, the basal segment is brown, the second has a yellow apical border, the remainder dark brown.

"The legs are dull, pale yellowish, somewhat transparent basally; the feet dark brown, the apex of femora and base of the tibiæ reddish-brown.

"The transparent wings are brown along the costa, and there is a dark brown vein below.

"The chaetotactic characters are very marked, there being four black bristles on the head, four on the front of the thorax, and two on each side of the median suture, one behind the root of the wings, and two long ones on the scutellum. The whole abdomen has fine, pale, backwardly-projecting bristle-like hairs. Length, 10·5 mm."

I am indebted to Mr. Harold H. King, Economic Entomologist to the Wellcome Research Laboratories, for specimens of this very interesting fruit-fly.

The Olive Fly.

(Pl. I, fig. 2.)

Dacus oleæ, Rossi.

(Fauna Etrusca, 11, 317, 1538, 1780.)

There is no species of the genus that causes more damage than the olive-fly of the Mediterranean region. The adult fly punctures the ripening olive and deposits its eggs beneath the skin. The maggots feeding upon the tissue

cause the olives to wither and drop off, and for many years have thus caused an immense reduction in the output of olive oil, particularly in Italy and Sicily. Last year it was estimated to have destroyed 10 per cent. of the total olive crop of Italy. Not only have the producers lost money, but the Government have had to reduce the taxes in the badly-infested districts. The pest has been gradually increasing every year, the returns of 1879–83, when the yield was 3,390,000 hectolitres of oil, have been reduced to 2,005,000 in 1895–99. As a large reward has been offered by the Government for any effective remedy or cure for this pest, all the entomologists have been studying the olive-fly, and carrying out experiments towards its eradication. When it is understood that the olive trees are grown on all kinds of rugged stony hillsides, and the olives are so small that it is a very different thing to clean up an olive plantation than an orange orchard, the difficulties of the situation can be understood.

Professor F. Silvestri, of Naples, advocates parasites, but no parasite of any commercial value has been discovered, though several have been bred from the pupæ of the olive-fly.

Dr. A. Berlese, of Florence, has carried out many experiments in trying to attract the flies with sweetened poisoned mixtures, with a certain amount of success.

The olive-fly is one of the smallest species, not more than 2½ lines in length. The wings hyaline, with dark nervures, very slightly clouded with yellow at the extremity of the first parallel vein, a small black spot at the extreme tip, and faint clouding of brown on the submarginal cell. The head dull yellow, eyes black, with a black spot below the base of the antennæ, the latter blackish at the extremities, a few black bristles on the summit. The thorax black, with the dorsal surface clothed with fine silvery pubescence, so that the black forms three narrow parallel black lines on the thorax; legs, nude patches on the sides of the shoulders, and the area above and below the base of the wings yellow, inner portion of the scutellum black, hind portion yellow. The abdomen black, covered with a scattered grey pubescence, the basal segments marked with pale transverse bands, and an irregular parallel bar or blotch of reddish-brown occupying the centre of the apical segments, the apical segment reddish-yellow, with the sheath of the ovipositor black, with the ovipositor reddish.

As might be supposed, there has been a great deal written about this destructive fly. In "Observations upon recent literature relating to the Olive Pest," Professor Guercio gives a list of thirteen papers published in Italy between the years 1877 and 1907, dealing with the olive fly generally, and there are many other special reports. Dr. Navarro, in his "Memoir relative to the Diseases of the Olive" (published in Madrid, 1898, for the Ministerio de Fomento), gives a very good account of the olive-fly in Spain, which is illustrated with a plate showing how it damages the olive.

As far back as 1822 Briganti (Atti del Real Institute di Napoli) gave an account of this pest, and four years later (1826), gave a detailed description of its metamorphoses and life history.

Westwood ("Modern Classification of Insects," 1840) says: "It is known to the natives of Provence under the name of Chiron. It is of a whitish colour; its mouth is furnished with two hooks; it at first feeds on the young leaves, but afterwards penetrates into the fruit." Of course, the statement that the maggot first feeds upon the young leaves of the olive tree is incorrect.

Broun's Fruit Fly.

(Pl. I, fig. 3.)

Dacus (*Tephrites*) *xanthodes*, Broun.

(Transactions of the New Zealand Institute, XXXVII, p. 327, 1904.)

This name was given to a species, bred by Captain Broun in New Zealand, from larvæ obtained infesting pine-apples, granadillas, guavas, and mammee apples brought from Suva and Rarotonga, Fiji.

He says: "It differs from *Trypeta psidii* in being longer, differently coloured and sculptured, and having no dusky areas on the wings. From *Dacus tryoni* it is distinguished by a greater length of body and expanse of wing, uniform coloration, without fuscous or yellow marks, dissimilar clothing and sculpture, less broadly oviform or wasp-like hind body and stout antennal setæ. In *D. tryoni* the flanks of the sternum are fuscous."

Before describing this insect, Captain Broun sent me several specimens, to see whether I could identify it for him; but we have never bred this species from imported fruit, and it has never been recorded from Australia.

Briefly, it may be thus described: Length of body, 4½ lines; expanse of wings, 7½ lines; eyes dark, face unspotted, with very few black bristles on the head; general colour, pale ochreous yellow, with the tarsi brownish, and the abdomen somewhat darker than the thorax. A faint yellow dorsal stripe on thorax, running through the centre of the scutellum, with a pale yellowish-white stripe margining each side and marking the sides of the scutellum, which is very prominent and arcuate behind; only a few black bristles on either side of the thorax. The wings are hyaline, with only the costal nervure and the next parallel vein slightly ochreous; abdomen of female elongated, and truncate at apex.

The Large Australian Fruit Fly.

(Pl. III, fig. 11.)

Dacus æqualis, Coquillet.

(Proceedings of the Linnean Society, N.S.W., 1908.)

This is one of our largest fruit-flies, and is remarkable for the very broad, dark ferruginous stripe along the front margin of the wing, the long antennæ, and very wasp-shaped body. Several specimens were obtained by Mr. A. T. Hunter in the maggot state in oranges growing near Gosford, New South Wales. These maggots were bred out in the Entomological Laboratory, and found to be a very different species to the common Queensland fruit-fly. When in Washington last year, I submitted specimens to Mr. Coquillet for determination. He has since sent me a technical description for publication under the above name. This description has been published in the Proceedings of the Linnean Society of New South Wales for this year, (1908).

The type will, therefore, be in the National Museum at Washington, U.S.A.; a second specimen I presented to the Entomological Collections of the Imperial Research Laboratories at Pusa, India; and another co-type is in the departmental collections in Sydney. It comes close to *Dacus lounsburyi*, Coq., from South Africa, and *Dacus longicornis*, Wied., from India and Java.

Dacus æqualis, Coquillet.—"Near *longicornis*, Wiedemann, from Java, but differing from the description in having the occiput chiefly reddish-brown instead of yellowish, the pleura has two yellow streaks instead of black ones, the anal cell is brown, &c. The evenness of the costal brown area of the wings, which is bounded by the costa and fourth vein, will serve to distinguish the present species from most of others. Reddish-brown, front mottled with yellow, face yellow, an elongated black mark on each side; cheeks margin of occiput, humeri, a streak extending along the mesothoracic suture each side and crossing the mesopleura, a large spot on the hypopleura, the scutellum, except the base, halteres, sides and hind margin of the second segment of the abdomen, narrow hind margin of the fifth segment, also the tarsi, pale yellow; femora largely blackish-brown. Antennæ projecting about half the length of the third joint below the oral margin. Abdomen broadly clavate slightly longer than the ovipositor of the female. Wings greyish hyaline, the front margin from the costa to the fourth vein wholly dark brown, anal cell brown, the constricted outer portion and the vein beyond it broadly bordered with brown." Length (excluding the ovipositor), 8 to 9 mm.

Dacus frenchi., n.sp.

(Pl. I, fig. 4.)

This species was figured in a coloured plate in an article on Fruit Flies, written by Mr. C. French, Government Entomologist in Victoria, in their *Journal of Agriculture*, May, 1907, which was issued afterwards as Bulletin No. 26, Department of Agriculture, Victoria. In this paper there is no attempt to describe or name this handsome fly, French simply calls attention to it, having been bred from oranges coming into Victoria from New Caledonia. In the plate the coloration of the wings is accurate, but the pattern upon the thorax is very misleading, as it shows a transverse band of four yellow marks occupying the centre of the dorsal surface, whereas there is only a light broad bar in the centre forming a silvery-brown dorsal stripe.

This is a large species, measuring 10 mm., with a broad rounded body and the large hyaline wings, with a broad costal stripe of light reddish-brown running right round the tip so that it forms a terminal fourth oblique band on the wing, at the basal half is a double band forming an irregular triangle with a clear centre, and other oblique bands (the first broadest) between it and the stripe, running round the extremity, so that there are four oblique transverse bands crossing the wing in a downward direction.

Head: proboscis fuscous, with a large black spot on either side below the base of the antennæ; eyes reddish-brown, with dark prominent reddish blotch in centre of face with a row of stout bristles along the hind margin of the head. Thorax dull yellowish-brown, with the nude areas on the shoulders, the sides and the scutellum very pale yellow, broadest in front, slightly truncate behind; the dorsal surface of the thorax clouded with black in an indistinct pattern forming two slight parallel dark bars, the centre pale, and the whole clothed with silvery pubescence. Legs yellow, with the tarsi darkest, clothed with fine hairs, spines black. Abdomen finely pubescent, broadly rounded, with the ovipositor and sheath very much produced; general colour pale ochreous yellow, with the base, a short band on the second segment, and a narrow well-defined narrow parallel black band crossing through the centre of third, fourth, and fifth segments, and a confluent blotch occupying the sides of the third and fourth segments.

Habitat—New Caledonia. One female specimen.

Dacus ornatissimus, n. sp.

(Pl. IV, fig. 13 and 14.)

General light chestnut brown to ochreous; wings hyaline, with a fine, pale ferruginous stripe along the costal nervure, except the basal cells, which are unclouded, a transverse stripe down the inner edge of the wing; length, 6 mm.; eyes almost black; antennæ moderately long, touched with fuscous at the tip, a round black spot on either side of the face below the antennæ, and four small spots above, and a few short bristles on the vertex; thorax without yellow markings, but the dorsal surface is occupied with a well-defined black pattern formed of two short parallel bars in line with the inner margins of the eyes, merging into an irregular transverse band through the mesonotum, which is continued in a broken band round the sides; a black blotch on the ventral surface below and between the forelegs, with another just behind the base of the wings; the whole of the dorsal surface of the thorax black, behind which is the broadly rounded chestnut-coloured scutellum, from the hind margin of which stand out two stout bristles; below the scutellum, above the base of the abdomen, are two well-defined black blotches; legs yellow, the tarsi slightly clouded; abdomen ochreous, with indistinct narrow transverse lines of darker colour, but no defined bands.

Habitat—New Caledonia.—Bred from mandarins in Sydney.

Dacus curvipennis, n. sp.

(Pl. IV, fig. 15 and 16.)

This is a handsome, dark yellow and black fruit-fly, of medium size, with hyaline wings with the costal margin clouded forming a regular narrow band extending round the tip of the wing, a small V-shaped blotch extends downward from the costal stripe clouding either side of the transverse cross nervure between the first posterior and basal cell, with the usual stripe down the inner side of the wing. Length, 6 mm. Head yellow, eyes purplish-black, antennæ fuscous at the tips, bristles black, without black spots on the face; thorax, with the whole of the dorsal surface covered with a dark shield-shaped black patch, with the centre covered with an elongate double bar of silvery white; the shoulders, sides of the body, and scutellum bright yellow, a narrow band or short bar of the same colour on the sides of the thorax; the scutellum somewhat elongated when viewed from behind, more convex when viewed from above, with two bristles at the hind margin; a few scattered bristles on the hind margin of the head and the sides of the thorax; legs yellow, thighs of hind legs and tarsi darker; abdomen elongate, with the base and two narrow transverse black bands below, the second broadest on the sides; sheath and ovipositor elongated.

Habitat—Fiji. Bred in Sydney from larvæ taken from bananas in shipments of fruit from Suva. Several specimens of both sexes. Type in Agricultural Department's collection, New South Wales.

Dacus basilis, Walker.

(List of Diptera, British Museum, Part iii, 1849, p. 1072.)

"Body bluish-green, head tawny, black beneath and on the crown; a white stripe along each eye; face white, its sides without bristles; epistoma prominent; eyes pitchy; fore parts flat, the facets much larger than those elsewhere; sucker black, clothed with tawny hairs; palpi tawny, rather large,

beset with black bristles; feelers ferruginous, full as long as the face, third joint linear, slender, pitchy towards the tip, more than four times the length of the second; bristles slender, black, bare, tawny towards the base, much longer than the third joint; chest covered with whitish bloom; abdomen linear tawny towards the base beneath, much longer and narrower than the chest; legs ferruginous, clothed with very short black hairs; feet pitchy towards the tips; claws black; foot cushions tawny; wings slightly grey, brown along the fore border from near one-third of the length to the tip; middle and lower cross veins clouded with brown, which has the darkest hue on the former; wing ribs ferruginous, veins pitchy, ferruginous towards the base, longitudinal veins nearly straight; middle cross vein very oblique, lower cross vein nearly upright, parted by little less than its length from the middle cross vein by much more than its length from the tip of the wing, and by little more than one-fourth of its length from the hind border; poisers pale tawny; length of body, 2¾ lines; of the wings, 5 lines."

Habitat—Port Essington, North Australia (Gould's Collection).

Dacus longistylus, Wiedemann.

(Auss. Zweifl., Vol. ii, p. 522, Plate X, fig. 1, 1828–30.)

Wiedemann says: "General colour dull reddish, with the thorax spotted, scutellum very pale yellow. Abdomen yellow, banded; wings, marked at the apex with dusky brown."

Length, 3½ lines. Habitat—Egypt.

There are a number of specimens determined by Löew in the K. K. Hofmuseum at Vienna under this name that were collected in Cairo, Egypt, 1858. In the Royal Museum of Hungary, at Budapest, there are other specimens labelled Assouan, Egypt. Though this is a common species in Egypt, I did not find any specimens in the departmental collections when going through them with Mr. Willcocks. The species from the Soudan, described by Theobald, is closely allied, and may be identical with this species.

I made the following rough notes on this species in the Vienna Museum: "Rather bright reddish-brown, with the nude patches on the shoulders, the angular nude patches on the sides of the mesonotum in front of the wings, and the scutellum bright yellow. The abdomen reddish-brown with three transverse yellow bands. Wings hyaline, with dusky band along the costal cells."

Habitat—Egypt.

Dacus maculiger, Doleschall.

(Natuurk. Tidjschr van Nederl, Indie, Vol. XVII, 122, 79 [*Bactrocera maculiger*].)

This is a very distinct species, originally described from Amboina. There are four specimens labelled "Collected Thorey, Cape York, 1868," in the K. K. Naturhistor Hofmuseum at Vienna, but Dr. Handlirsch informed me that the locality might not be exact, as Thorey was a dealer, and the specimens had probably been bought from him. They appear to be very close to the typical specimen, and are labelled by Loew (who determined many of the diptera in this museum) *Dasyneura zonala*, Saund., or *maculiger*, Dol.

Head and thorax yellow, dorsal surface of the thorax curiously patterned in slate-grey, forming a large patch in the centre truncate behind the head,

forking into a bar on either side, with the hind portion produced into two bars running to the sides behind. Abdomen yellow, with a narrow brown band at the base, below which, across the middle, a broader band encircles it with a well-defined parallel band running down the centre of the apical segments to the anal extremity. Legs yellow, mottled with brown. The wings hyaline, with the exception of the clouded margin at the tip, and an oblique stripe in a line with the body.

In the specimens said to come from Cape York the colours are darker, but the yellow markings on the front and sides of thorax and scutellum are brighter yellow.

Habitat—Amboina.

Dacus punctatifrons, Karsch.

(Entomologische Nachrichten, Vol. XIII, p. 8, 1887.)

"General colour reddish-brown to dull brown, clothed with short grey pubescence. The face yellow, punctate in front, marked on each side with three large black spots ornamenting the antennæ below on each side; antennæ elongate; legs reddish-brown; thorax on each side striated, shoulders shining pale yellow; scutellum pale yellow; abdomen ovate, the dorsal surface of the hind margin of the second segment yellow, the remaining segments yellow in the centre with the anal segment short and brown; wings hyaline, costa banded to the last nervure brownish, transverse nervure small, apparently brown on the edge. Length, 8 mm."

Habitat—Pangi Andongo.

Dacus caudatus, Fabricius.

(Syst. Antl. 276, 16, 1805; Wiedemann, Auss. Zweifl., 11, 518, 8, 1828–30; Walker, List Diptera, British Museum, IV, 1073, 1848–55.)

This species is described from Java. There is a specimen in Mr. Verrall's collection under this name.

It is a rather small species, of a general light yellow colour, with indistinct dark yellow spots and marks on the thorax, the scutellum prominent; abdomen yellow, crossed with two narrow transverse black bands above, with a fine line of the same colour forming a dorsal stripe from the base to the tip of the abdomen with an irregular blotch on either side. The hyaline wings with a dark costal stripe, with two irregular spots below crossing the wing.

Wiedemann says: "General colour yellow, thorax mottled with yellow and black, abdomen marked with black stripes, and a band; wings and costa with an oblique short stripe and bands of brown. Length: Male, 5½ lines; female, 4 lines. Habitat—Java."

Fabricius: *D. caudatus* yellow; thorax greyish, with a yellow spot; wings hyaline, with the curved bases black."

As large as *D. stylati*; head yellow; front of face spotted with black; thorax greyish; nude patches on shoulders, lateral lines, and hind margin of the scutellum yellow; abdomen oval, yellow, with a stripe of black in the centre; ovipositor elongated; wings white hyaline; costa clouded, base with clear markings, and, moreover, curved to the black base.

Dacus fascipennis, Wiedemann.

(Zoologisches Magazin, Vol. III, 28, 42, 1817–23; Auss. Zweifl., Vol. II, 519, 9, 1828–30: Van de Wulp, Tijdschr v., Entom. XXIII, 181, 42, pl. 11, f. 4, 1880; *Bactrocera fasciatipennis*, Doleschall, Natuurk Tijdschr, van Nederl. Indie, X, 1856, 412, 56, pl. 3, f. 1. Java and Sumatra).

There is a specimen in the Royal Museum of Hungary, said to have been determined by Wiedemann from Astrolobe Bay, New Guinea. Wiedemann says: "Fuscous marked with yellow, costal portion of the wings dusky with three honeycomb-like blotches at the end." Length: Male, 3¼ lines. Habitat—Java.

Dacus emittens, Walker.

(Pro. Linnean Society, Vol. IV, 1860, 152–184; Osten-Saken, Annali del Museo Genova, XVI, 1881, 460.)

A very large species, dark brown to ochreous, with the hyaline wings clouded with a fuscous blotch towards the apical half, and stained along the costal nervure with a similar tint. The head yellow; sides of the thorax darkest; scutellum stained, probably yellow, with two stout bristles on the hind margin. The abdomen yellow, with a very distinct pattern, the base lightly marked with black, an elongated spot or short bar in the centre of the basal half, with a narrow black line crossing the centre of the back, with a parallel one meeting it, and on the divisions on either side two black spots, the lower one smallest.

Several specimens in Mr. Verrall's collection, labelled Celebes, by Bigot.

Dacus frauenfeldi, Schiner.

(Reise Novara Zoology Diptera, 1868, p. 262.)

"Dorsal surface of thorax blackish-brown, with three broad, grey, longitudinal stripes, formed or continued from the fine, glittering, white pubescence, the outer ones close to the edge of the dorsal surface; the sides at base of the wing-bosses on the shoulders, and scutellum reddish-yellow, the latter with a broadened middle, black at the base; apex of the thorax shining black, broadest on the sides. Abdomen with a transverse yellow band interrupted in the middle at the margin of the second segment with two yellowish black stripes, sometimes white, run down to the anal segment, the latter yellow with black line behind, moderately short; sheath of ovipositer reddish-yellow; the under surface of the abdomen completely yellow. Head, orange, with the bristles black; antennæ with a black spot on the sides below the base; antennæ bright orange, broad, the last joint truncate at the tip; the bristle bare. Legs pale yellow, blackish at base, thighs clouded with reddish-brown, the tibiæ, legs, and tarsi reddish-brown. Wings hyaline, with two arched bands; the upper, beginning at the base, follows the cubital vein up to the little cross vein, then goes over this and the hinder cross vein to the edge of the wing, the lower one covering the anal vein. The little cross vein is very oblique; the hinder one, too, is oblique, placed outwards, and both coming close together. Anal cell suddenly narrowed, and long drawn out underneath the 4th.

"One male and two female specimens. Habitat, Stuart Island."

"The clouding of the base of the thighs is often very variable in the brightly-coloured male, the stripes on the abdomen broader than in the female. I have carefully compared all Walker's species of Dacus, and found none that could be identical with my species. It seems to me, moreover, that the most of these species (Walker's) may not belong to the genus Dacus."

Dacus africanus, Adams.

(The Kansas University Science Bulletin, Vol. III, No. 6, October, 1905, pp. 149–208.)

This is a species of fruit-fly described in the above publication by C. F. Adams, in a paper entitled "Diptera Africana, 1." The specimens were collected by Mr. F. L. Snow, near Salisbury, Rhodesia, South Africa.

"Male: close to *D. brevis*, Coq., and *D. sigmoides*, Coq., from Cape Colony. Head yellow; front reddish-yellow in the middle, greyish pollinose along the orbits, ocellar dot, frontal lunule, three spots on orbits, and a spot in the centre of front, black; the three spots on orbits each bears a black, bristly hair; a vertical and post-vertical bristle present; face straight, sloping on the sides; cheeks yellow, and furnished with a black spot below eyes; occiput yellow and reddish-yellow variegated; antennæ about as long as head, yellow, tip of third joint and arista largely blackish. Thorax opaque reddish, finely scrobiculate, sparse pile whitish; humeri, a stripe beginning on upper margin of sternopleuræ, traversing the mesopleuræ and along transverse suture to near middle of mesonotum, a spot on metapluræ, the scutellum, except the extreme base, and halteres, yellow; two small spots just in front of transverse suture, two large ones behind it, a stripe just in front of the yellow of the mesopleuræ, the sternopleuræ largely, two spots on metanotum and metapleura largely blackish; three small black bristles between humeri on anterior margin of thorax, one on side just behind humeri, one at base of transverse suture, one postalar, one transalar, an apical pair of scutellar bristles, and one mesopleural bristle present. Abdomen reddish, finely scrobiculate, and with whitish sparse pile; third segment laterally along posterior margin, with a short row of black bristles; venter yellowish. Legs light yellow; coxae blackish at base; femora on apical fourth, tibiæ wholly, the tarsi apically, reddish-yellow. Wings hyaline; a fuscous stripe along first vein, from base to apex, thence along costa to tip of third vein, and another one along lobe of anal cell to wing margin; auxiliary cell rudimentary; tips of third and fourth veins nearly straight; small cross-vein inclined forward.—Length, 7 mm."

One specimen collected in June.

List of Walker's species.

These species of the genus *Dacus* were described by him, from specimens collected by A. R. Wallace in the Malay Archipelago, in a series of papers entitled "Catalogue of Dipterous Insects," &c., eleven in number, published in the Proceedings of the Linnean Society between the years 1857 and 1865. These descriptions are very brief, and as the types are not in existence, or, at any rate, their whereabouts unknown, it is very difficult to determine any of his species. The descriptions can be seen in the Pro. Linn. Society of the years mentioned.

1. *Dacus absolotus.* Vol. VI, 1862, p. 22. Ceram.
2. „ *addens.* Vol. IV, 1860. p. 149. Macassar.
3. „ *areolatus.* Vol. V, 1861, p. 295. Batjan.
4. „ *biarcuatus.* Vol. VIII, 1865, p. 122. New Guinea.
5. „ *bilineatis.* Vol. IV, 1860, p. 150. Macassar.
6. „ *concisus.* Vol. VII, 1864, p. 227. Waigoe.
7. „ *contrahens.* Vol. IV, 1860, p. 151. Macassar.
8. „ *curvifer.* Vol. VII, 1864, p. 229. Waigoe.
9. „ *conformis.* Vol. I, 1857, p. 34. Singapore, Celebes.
10. „ *detrudens.* Vol. VIII, 1865, p. 135. Salawatti.

11. *Dacus devius.* Vol. V, 1861, p. 250. Batjan.
12. „ *diffusus.* Vol. IV, 1860, p. 153. Macassar.
13. „ *divergens.* Vol. V, 1861, p. 149. Celebes.
14. „ *discipennis.* Vol. V, 1861, p. 294. Batjan.
15. „ *emittens.* Vol. IV, 1860, p. 152. Celebes.
16. „ *exigens.* Vol. IV, 1860, p. 151. Macassar.
17. „ *expertus.* Vol. VI, 1862, p. 14. Gilolo.
18. „ *expandens.* Vol. III, 1859, p. 114. Aroe.
19. „ *figuratus.* Vol. I, 1857, p. 133. Borneo.
20. „ *fulvitarsis.* Vol. IV, 1860, p. 153. Macassar.
21. „ *furcifer.* Vol. VI, 1862, p. 14. Gilolo and Ternate.
22. „ *helemyzoides.* Vol. VII, 1864, p. 220. Mysol.
23. „ *imitans.* Vol. IV, 1860, p. 152. Celebes.
24. „ *inaptus.* Vol. IV, 1860, p. 151. Macassar.
25. „ *inscriptis.* Vol. V, 1861, p. 162. Amboina.
26. „ *instablis.* Vol. V, 1861, p. 250. New Guinea.
27. „ *latifacia.* Vol. III, 1859, p. 114. Aroe.
28. „ *lateralis.* Vol. VIII, 1865, p. 123. Waigoe, New Guinea.
29. „ *lituratus.* Vol. V, 1861, p. 251. Waigoe, New Guinea.
30. „ *lativentris.* Vol. III, 1859, p. 115. Aroe.
31. „ *longivitta.* Vol. III, 1859, p. 115. Amboina, Aroe.
32. „ *mutilloides.* Vol. III, 1859, p. 115. Aroe, New Guinea.
33. „ *nigrilinea.* Vol. V, 1861, p. 251. New Guinea.
34. „ *perplexus.* Vol. VI, 1863, p. 14. Gilolo.
35. „ *pompilioides.* Vol. III, 1859, p. 116. Aroe.
36. „ *pectoralis.* Vol. III,1859, p. 114. Aroe, Batjan, Waigoe.
37. „ *replatus.* Vol. V, 1861, p. 296. Batjan, Kaisaa.
38. „ *pubisetu.* Vol. V, 1861, p. 294. Mysol, Batjan.
39. „ *sepsoides.* Vol. V, 1861, p. 163. Amboina, Batjan.
40. „ *sepedonoides.* Vol. VII, 1864, p. 228. Waigoe.
41. „ *speculifer.* Vol. VIII, 1865, p. 122. New Guinea.
42. „ *strigifer.* Vol. VI, 1862, p. 13. Gilolo.
43. „ *strigifinis.* Vol. V, 1861, p. 295. Batjan.
44. „ *sordidus.* Vol. V, 1861, p. 251. Mysol, Waigoe.
45. „ *signatipes.* Vol. V, 1861, p. 163. Amboina.
46. „ *terminifer.* Vol. IV, 1860, p. 152. Macassar.
47. „ *varialis.* Vol. VIII, 1865, p. 123. New Guinea.

There is a second species under the name of *divergens*, in Vol. V, 1861 . 149. Macassar, Batjan. .

The following species have been described from various localities, but I have not seen specimens in any of the collections examined.

48. *Dacus africanus.* C. F. Adams, Kansas University Science Bulletin 3, 1905.
49. „ *areoleucus.* Wiedemann, Auss. Zweifl., Vol. II, p. 520. Locality unknown.
50. „ *æneus.* Wiedemann, Auss. Zweifl., Vol. II, p. 513. Java.
51. „ *armatus.* Fabricius, Systema Antliatorum, 1805, 273. Wiedemann, Auss. Zweifl., Vol. II, p. 517, 1828-30. New Guinea.
52. „ *bicolor.* Wiedemann, Auss. Zweifl., Vol. II, p. 526. Brazil.
53. „ *braevipes.* Fabricius, Syst. Antl. 1805, 272; Wiedemann, Auss. Zweifl., Vol. II, p. 513. Brazil.

54. *Dacus brevistriga.* Walker, Trans. Ent. Soc., Vol. V, p. 323, 1858–61. Natal.
55. „ *flavicornis.* Wiedemann, Auss. Zweifl., Vol. II, p. 514. Brazil.
56. „ *fratereulus.* Wiedemann, Auss. Zweifl., Vol. II, p. 525. Brazil.
57. „ *fuscatus.* Wiedemann, Auss. Zweifl., Vol. II. Locality ?
58. „ *inflexus.* Fabricius, Syst. Antl., 1805, p. 273.
59. „ *incisus.* Walker, Trans. Ent. Soc., Vol. V, p. 323, 1858–61. Burmah.
60. „ *klugii.* Wiedemann, Analecta entomologica, 1824, 56, 125, and Auss. Zweifl., Vol. II, p. 523. East Indies.
61. „ *limbipennis.* Macquart, Dipteres Exotiques, 1838–42., Vol. II, 3, p. 217, plate 29, fig. 9. Java.
62. „ *icarus* Osten-Saken, Berlin Ent. Zeitschr., XXVI, p. 224, f. 8 1882. Philippines.
63. *Dacus maculentus.* Wiedemann, Auss. Zweifl., Vol. II, p. 525. Locality unknown.
64. „ *parallelus.* Wiedemann, Auss Zweifl., Vol. II, p. 515. Brazil.
65. „ *pectoralis.* Walker, Trans. Ent. Soc., Vol. V, page 322, 1858–61. Natal.
66. „ *ritsemæ.* Weyenberg, Archives Neerlandaises, IV, 1869, p. 60; Osten-Saken, Ann. Museo Genova, XVI, p. 460, 1881. Java.
67. „ *serpentinus.* Wiedemann, Auss. Zweifl., Vol. II, p. 521. Brazil.
68. „ *squalidus.* Walker, Trans. Ent. Soc., Vol. V, p. 323. Hindostan.
69. „ *trivittatus.* Walker, List of Diptera, British Museum, Vol. IV, 1072, 1849. Phillipines.
70. „ *umberosus.* Fabricius, Syst. Antl., 247; Wiedemann, Auss. Zweifl., Vol. II, p. 517. Sumatra.

The following names are attached to specimens of *Dacus* in Mr. Verrall's collection, said to be in Bigot's handwriting, but are probably MS. names, and no descriptions, as far as I can find, have been published of them :—

Dacus	*amoyensis.*	Bigot,	1845.	Amoy.
„	*fulriventris.*	„	„	New Guinea.
„	*ornatypes.*	„	„	India.
„	*rufipetia.*	„	„	Loc. ?
„	*fulvidus.*	„	1842.	India.
„	*pictus.*	„	„	Ceylon.

Genus—Ceratitis.

(Macleay, Zoological Journal, XVII, 1829; *Trypeta*, Wied.; *Petalophora*, Macq.; *Halterophora*, Rondani.)

This genus was created by Macleay for the fruit-fly he bred from the oranges from the Azores; he did not define either the generic characters of the group or the specific character of his new species, but instead sent a very fine, highly-magnified coloured drawing to Mr. Vigors, the editor of the *Zoological Journal*, which was beautifully reproduced on plate XV.

Wiedemann, who had described it in the genus *Trypeta*, still retained it in that genus when he published his general work on exotic diptera in 1830. Afterwards Macquart classed the genus *Petalophora* with this species in the Nouvelles Suites de Bufon, 1835. Guèrin, however, placed them in Macleay's genus when he published his Monograph of a Genus Muscidæ named *Ceratitis*, and in which he described three new species in 1842.

Rondani, in his Podromus Dipterologicæ Italicæ (1856–77), placed the members of this genus in a new genus he created, and which he called *Halterophora* because the name *Ceratitis* was preoccupied. This was followed by Penzig, in the Annali de Agricoltura, 1887. Tryon used the later name, which I followed in my Notes on Fruit Flies (*Agricultural Gazette, New South Wales*, 1899). On looking up Rondani's reasons, I find that the word *Ceratitis* has, according to Packard's list of genera, been used three times: for Molluscia Hann, 1825; Macleay Diptera, 1829; and Servielle Coleoptera, 1835. However, I do not see why we should discard it, for it is such a characteristic name, and is not likely to clash with the name of a group of molluscia. I have, therefore, returned to the old name because, too, it is still the recognised name for this group in Europe and America.

The Mediterranean Fruit Fly.

(Pl. VIII., figs. 1a, 2a, 3, 4a; Pl. V., fig. 18.)

Ceratitis capitata, Wiedemann.

(*Tephritis capitata*, Wiedemann, Analecta Entomologica, p. 55, Vol. IV, 1824; *Ceratitis citriperde*, Macleay, Zoological Journal, XVII, p. 475, pl. xv, 1829; *Ceratitis hispanica*, de Brême, Annals de la Société Entomologique, Vol. XI, p. 189, pl. vii, 1842).

Though Wiedemann first described this species, it was Macleay's paper, "Notice of *Ceratitis citriperda*, an insect very destructive to oranges," that first called attention to it as an orange pest, under the very appropriate name of *Ceratitis citriperda*. In this paper he states that he had obtained specimens from the Azores, where they infested a great quantity of the oranges, at that date sent from these islands to the London markets. He says: "I ought, however, to observe that I have seen the perfect fly on a heap of oranges in the market place of Funchal, in the island of Madeira, and also in St. Jago, one of the Cape Verds. I am informed, moreover, that a maggot infests oranges in the West Indies, but I have not myself yet seen it." In this very interesting paper, Macleay makes some general remarks on the cleaning up of orchards, which are just as applicable to the fruit-growers of to-day as they were eighty years ago.

Wiedemann described this species, and said his specimens came from the East Indies, and his type, if it still exists, will be found in the Royal Museum of Copenhagen. All the writers that have followed Wiedemann and Macleay have taken it for granted that they described the same species, one from the Azores Islands (though now known all over the Mediterranean region) and the other from the East Indies; yet if the locality of Wiedemann's specimens is correct, it is very strange that *Ceratitis capitata* has never been discovered in that part of the world since Wiedemann obtained it. We have the exact locality of Macleay's specimens, while Wiedemann's is the East Indies, a variable locality in those days.

M. Cattoire, who had been paymaster of the troops in Mauritius, had noticed oranges infested with maggots in the orange groves of that island. He wrote to Macleay and sent him a specimen, which was, unfortunately, a female, in which the specific characters were not so easily defined. This Macleay considered identical with his species; and misled probably by second-hand observations, he said the fly deposited her eggs in the ovary of the orange flowers, and that the larvæ developed with the fruit. This species was afterwards defined by Guèrin, who gave it specific rank as *Ceratitis cattoirei*.

The Marquis de Brême, in 1842, described specimens which he obtained from oranges at Malaga, southern Spain, and which he considered distinct from Macleay's species, under the name of *Ceratitis hispanica*, and figured both species in colours. Though there are some slight differences, it is now fairly evident that de Brême's species is identical with that of Macleay and Wiedemann.

The original home of *Ceratitis capitata* is, probably, Spain, one of the great homes of the orange, and from which, at the present time, a great quantity come into the British markets. From there it was carried to the Azores and the orange-growing islands of that region at a very early date. It extends right round the Mediterranean; it is found in the south of France, and there are several instances of slight outbreaks close to Paris; but it has never become established in such northern latitudes. In England, there are specimens in the Oxford Museum. These were recorded by Westwood in the *Gardeners' Chronicle*, 1848, "captured in Thames-street, London, 1848," and others were bred from maggots in imported oranges. It is plentiful in Valencia and Malaga; at times it destroys a great quantity of oranges in the latter town towards the end of the season.

It is found in southern Italy, at Calabria, and is recorded as a serious pest at times. It is well known in Sicily, where a number of reports have been published concerning its depredations, and it is locally known as *la mosco delle arance*. In 1879–80 it did a great deal of damage in the neighbourhood of Messina, and also again in 1882.

I could obtain no record of it in the Greek Archipelago, nor did I find it in the markets of Turkey; but in Malta it was recorded, according to Henslow, as a pest in 1875. In the *Gardeners' Chronicle*, 1890, he stated that it had been a serious pest for the preceding three years upon mandarin oranges, and he noticed that the flies were always most numerous in the hot, dry seasons, and particularly scarce in cold, wet ones.

In 1889 a committee was appointed by the Governor of Malta to draw up a report on the pest, and on the best methods of dealing with it. They recommended that all fruit infested should be collected and destroyed, and suggested strewing the surface of the ground with 1 part of sulphate of iron to 24 parts of sand, the ground to be subsequently watered.

I have been unable to obtain any data of how the pest is controlled at the present time in Malta.

It was introduced into southern Africa many years ago, and Miss Ormerod, in her "Observations on some injurious insects of South Africa," gives an account of the damage it does at the Cape. In Natal and some of the other African States several native species of *Ceratitis* have been described as pests that have turned their attention to cultivated fruits; but Fuller has lately recorded the appearance of this species in the Natal orchards in the Fourth

Report of the Government Entomologist, 1903–4. In this report Fuller states: "Amongst the batch of newly-observed pests which I have to record is that known as the Mediterranean Fruit Fly (*Ceratitis capitata*)."

There are a number of different species of the genus *Ceratitis* found in the southern half of Africa, so that it almost appears to be the home of the group; and our particular species, *C. capitata*, may have been a native of northern Africa and crossed over into southern Spain.

In the tropical portion of the eastern coast of South America, Lounsbury found this Mediterranean fruit-fly widely distributed and one of the worst fruit pests; but it was there thought to be an introduced fly of somewhat recent date.

None of the countries of North America or the West Indian Islands (with the exception of Bermuda) are infested with this fruit-fly, though the conditions seem well adapted to its habits.

It was recorded as a peach-pest in Bermuda in 1890 in "Insect Life"; but is said to have infested fruit on this island for about forty years. Howard, when he identified the species, suggested that the orchardists should clean up their orchards and burn or bury all infested fruit; but no particular measures were taken until last year, when the Board of Agriculture had an Act passed, entitled the Fruit Fly Destruction Act of 1907. This Act came into force on 1st March of that year, the Legislature having granted £500 for the purpose of carrying out the recommendations of the Board of Agriculture, namely, "that an attempt be made to eradicate the insect pest known as the fruit-fly (*Ceratitis capitata*)." The following remarks are taken from a report furnished by Mr. T. I. Harris, Director of the Public Gardens, under whose supervision the work was placed, and which was printed in *The Bermuda Colonist*, 12th August, 1907:—

"It is almost safe to assert that the flies of each succeeding generation remain around about the trees whose fruits afford the food necessary for the maggot; and from this it might be inferred that if fruit-growing became an industry in Bermuda, the planting of orchards of mixed fruit-trees is to be particularly avoided, unless growers are prepared to keep the ground under the trees perfectly clear of weeds, and to collect and destroy promptly all fallen fruit.

"Though the great variety of fruiting-trees growing here is insufficient to furnish propagating media for flies throughout the whole year, each successive generation making use of a different kind of fruit, without doubt the Surinam cherry (*Eugenia Michili*) has been the most potent factor in perpetuating the pest. There are two main crops of fruit, one in the spring and another in the fall, but stragglers between each cause the two crops to overlap.

"The loquats (*Eriobotrya japonica*), ripening in February and March, are used by the fruit-flies of the year, from the puparia that have lived dormant in the ground during the two coldest months, and the larvæ hatched from the eggs of these flies begin to pupate before the loquats are all over. In some instances this year, where the fruit had been pecked by birds and had shrivelled on the trees, complete pupae were found within the fruit. At the end of April and during May, the peach, cherry, oranges (both sweet and sour), lemons and limes, Barbados gooseberry, and capsicums bring forth another crop of maggots that, after pupation, are just in time for the sapodillas in June and July. Following these are the mangoes, coffee, sweet peppers, cherries again, avacado pears, guavas, sugar apples, cherimoyas, quinces, coco-plum, granadillas, and star apples, which serve as propagating media until the final resting brood goes to earth during December.

"The general plan has been to collect and destroy all the mature fruits of all kinds known to be punctured throughout the country; and in such cases, where trees bearing large numbers of small fruit are too numerous, about 90 per cent. have been pruned back to prevent their producing fruit during the next fruiting season; by doing this it is possible to collect all the fruits produced by the trees that were left unpruned last season.

"The fruits were collected in sacks, weighted by inserting a big stone before closing the bag, and thrown into the sea. In a few instances it proved more convenient to burn or boil the fruits.

"The work was begun as soon as possible after the Act came into force. Ten sets of tools were purchased, and an inspector was appointed for each of the nine parishes, and the inspectors were supplied with labourers as necessity demanded."

In reply to my request for further information, Mr. Harris sent me a copy of their Act and an interesting letter, part of which I extract. He says:—

"We are working here in Bermuda on the assumption that the female fly dies after all its eggs have been laid, and that if we carefully collect the fruits as soon as the eggs are laid in them, we get at the root of the trouble. We had already, last year, reduced the number of fruit-trees about to just a few in each parish, and these are being kept under close observation. At this time (1st March) last year there were, I should say, several millions of loquat fruits teeming with maggots and the fruit rotting on the ground. This year the observation trees that were permitted to fruit have proved to us that we are working on the right lines. Of about 100 trees we left to fruit in the whole country, about seventy have matured their fruits without a single puncture, while the remainder have had less than 50 per cent. punctured once or twice, and these have all been collected. For the last fifty years the peaches have begun to ooze sap when they were as large as marbles; this year, now, the trees are laden with fruit as large as hen's eggs and not a single one punctured.

"We were careful, you see, not to destroy all the fruit, fearing that the fly went about and punctured things unknown to us; they appear to find their way to the observation trees, but I am of opinion that they do not, as a rule, travel very far; indeed, I had come to that conclusion last summer, that if one orchardist were to collect and destroy all diseased fruit and his neighbours did not, his neighbours' flies would not go over the fence unless they were blown over by the wind. We had at the end of last summer sapodillas (*Achras sopota*) and anonas quite free of maggots, and also a few late peaches.

"I have at the garden two large loquat trees near some old peach trees; all are in full fruit, the peaches quite large and no sign of a puncture, while the loquats show 50 per cent. with just one deposit of eggs each. I have caught and killed five flies on the two trees—the last a week ago,—and now there are no more; have gathered all the 'stung' fruit and am leaving the rest to ripen. The flies appear to prefer ripe loquats to unripe peaches, for the branches of both trees intermingle yet the peaches are not punctured.

"I notice also that the punctured spots contain from two to five eggs this year, whereas last year at this time as many as twelve and fourteen were found in each hole, while each fruit was punctured in as many as twenty places.

"It is very evident also that the flies go about 'stinging' the fruit some time after all the eggs are laid, for many of the single punctures contain no eggs at all, yet the flesh of the fruit is killed at that point, the dead portion being $\frac{3}{16}$ of an inch wide and a $\frac{1}{4}$ deep. Can you say what the poison is?"

The first record of *Ceratitis capitata* in Australia was made by Fuller (*Journal of the Bureau of Agriculture*, W.A., February, 1897). Later on he stated that it was first observed at Guildford in October and November of the previous year infesting limes, afterwards in apricots, and towards the end of the year in peaches, nectarines, and figs. In the March number of the same journal he gave a good plate of the fly and its life history. Tryon in the meantime received specimens from Western Australia, and determined it as the well-known fruit pest of the Mediterranean (*H. capitata*). In the following year (1898) French wrote to me from Melbourne stating that he had bred this fly from peaches imported into Victoria from Sydney, and a few days later I was surprised to find a number of the identical species flying about in the breeding-jars in my laboratory, breeding from fruit that was supposed to be infected with Queensland fruit-fly. As we were all on the lookout for this fruit pest at the time, there can be no doubt about the time of its arrival in Sydney. It was established in Western Australia nearly two years before it was discovered in Sydney; at that time a good deal of citrus fruit was being imported into Australia *viâ* Italy, though some of it was brought in the first instance from the African coast and reshipped from Naples. At that time, too, fruit-fly was common in the African oranges, and also in southern Italy and Sicily. Therefore there is very strong evidence that we got it from European countries; and though we may have had it direct from Western Australia, it is just as likely that it was brought to us by fruit in one of the mail steamers. The popular name, "Mediterranean Fruit Fly," was first used by me ("Notes on Fruit-maggot Flies, with descriptions of New Species," *Agricultural Gazette* of *New South Wales*) to distinguish it from the northern species, which we call the "Queensland Fruit Fly" (*Dacus tryoni*).

This fly has spread all through the citrus orchards of New South Wales to a greater or less extent, but until a few years ago was unknown in the southern parts of this State and the adjoining State of Victoria. At the present time, however, it is found in orchards at Albury and in quite a number of Victorian orchards, where it has become more or less established.

For a long time it was believed that it was not to be found in Queensland; and though, from what I can learn, it is not common, yet it is found in Queensland fruit, and I have specimens from Brisbane. Though it has been introduced into Tasmania several times in damaged fruit, it has not gained a footing in that State; and South Australia is to be congratulated on keeping this pest out of its boundaries. In Western Australia, in the vicinity of Perth and all through the citrus orchards, it is as great a pest to fruit-growing as in the similar climate of New South Wales.

In New Zealand, according to their last Annual Report (1907), this fruit-fly has been introduced into that country on several occasions, and was established to the extent that fruit grown in Napier and sent to another part of New Zealand produced a large crop of Mediterranean fruit-flies. There is, however, without doubt a climate limit to the spread and development of this pest, even though it may appear in considerable numbers under particularly favourable conditions for one season, as it did in the neighbourhood of Paris in 1906, as described by Professor A. Giard.

From inquiries I made in Paris from Professor Marchel, it is evident that they did not become properly established, for they were not a pest the following year.

Ceratitis capitata, in the first place, is a citrus fruit pest, but as it has spread has learnt to feed upon all kinds of fruits; and after the orange may be known as a peach pest. At the present time there is hardly any kind of fruit that it has not been bred from, so that any list of infested fruit is quite superfluous. In fact, they have been bred from a number of native fruits; but the native fruits are so rare, comparatively speaking, in the greater part of the fruit-growing districts of Australia, that they are not an important factor in the spread of the pest, and are more likely to be infested themselves from an adjacent orchard than to be a centre of infection to the orchard. *Ceratitis capitata* has been described in a more or less imperfect manner a great many times, but is better known from the beautiful coloured figures, published by Macleay, and again by Brême, when he called it *C. hispanica*. As several new species have been added to the members of this genus, and some confusion exists about the identity of the earlier described species, I propose not to give a scientific description but a popular one, that anyone can grasp with the insect before them.

Size, 4 to 5 mm., about the size of an average house-fly, but looking somewhat smaller when dead, because the body shrinks up beneath the thorax. General colour, ochreous yellow, lighter on the sides of thorax and basal joints of the antennæ. The eyes of the usual reddish purple tint, with a blackish blotch in the centre of the forehead, from which spring two stout black bristles, a fine fringe of similar bristles round the hind margin of the head, with some coarser ones curving round in front of the head between the eyes. The thickened basal joints of the antennæ pale yellow, the terminal segments black to the tips. The dorsal surface of the thorax convex, raised, and broadly rounded with the scutellum, the ground colour creamy white to yellow, marbled with shining black blotches forming an irregular mosaic pattern, the lighter portions clothed with very fine white bristles. These light-coloured bristles more lightly scattered over the dark areas, and the whole bearing large stout black bristles thickest on the black surface.

In many of the pictures of this insect the black areas are drawn as if they were projecting bosses or knobs, but this is incorrect; the whole forms a regular rounded surface.

The wings are broad, semi-opaque, with the extreme base blotched with ochreous or brownish yellow, with the rest of the basal area curiously marked with black, forming dark lines of the radiating nervures, with dark lines and spots between; beyond this is a broad irregular transverse ochreous band, slightly lined with black, blotched at the extremity; another similar shaped and coloured blotch runs along inside but not in contact with the costal nervure, also black towards the extremity in the angular space. Between these bands is another shorter black band running parallel with the first transverse band.

The oval abdomen is clothed on the upper surface with fine, scattered black bristles, and has two rather broad transverse silvery white bands on the basal half of the body. The male differs from the female in being furnished with a pair of stalked appendages standing out in front of the head in a line with the front margin of the eyes, the extremities of which filaments are produced into spatulate appendages, black, finely striated, and diamond shaped.

The living fly is an active little creature, running about over the foliage or fruit on the trees, with its wings drooping down on the sides of the body. When disturbed it has a short flight, seldom flying more than a few yards at the most, and it often returns to the same spot.

Ceratitis punctata, Wiedemann.

(*Trypeta punctata*, Wiedemann, Analecta Entomol., 1824, p. 55, n. 123; Ausseurop. Zweiflugel Insecten, 2 Thl., 1830, 435, 15. *Ceratitis punctata*, Von Roder, Berl. Entomol Zeitschrift, 29 Jahry, 133, 2.)

Examining the Bigot collection (Mr. G. H. Verrall's), I found one specimen under this name which had the dorsal surface spotted, very like that of *C. capitata*.

In the Royal Museum of Hungary there is a specimen under this name, which has a uniform grey tint on the dorsal surface. The wing neuration as in *C. capitata*, at the base, but very irregularly barred on the apical portion. The dorsal surface of the thorax showing the same shining black areas, but in this specimen they appeared to form irregular raised bosses. It was labelled "German West Africa."

Ceratitis brêmii, Guérin.

(Rev. Zool., 1843, p. 199.)

General colour pale yellow, with the under surface of the thorax shaded with reddish, the whole insect covered with very close whitish-yellow pubescence, the colour of the sides. The scutellum black at the base, whitish-yellow in front, bordered with bright yellow behind, with longitudinal lines of the same bright yellow, which thus forms three large black square blotches. The wings resemble those of *Ceratitis cattoirei*, but showing only one oblique band of brown towards the lower edge of the wing, between the middle band and the side band, yellow from the side to the middle, transverse—and not in contact with the other bands.

Abdomen pale yellow, uniformly clothed with fine whitish-grey pubescence, with scattered black bristles on the sides and apex; legs pale yellow.

Length, 5 mm. Habitat—Senegal, Africa. One female specimen, collected by Captain Meon.

Ceratitis dentipes, Guérin.

(Rev. Zool., 1843, p. 200.)

The following account is translated from Guérin's description of this fly, which he appears to have placed in this genus, not because he was certain it belonged to it, but because he did not quite know where to place it.

In the Verrall collection there is a specimen labelled *Ceratitis dentipes*, Macq., which may be the type, as it is marked Port Jackson. There is only the head and wing remaining on the pin, but the latter is very different in its markings, which form lines and circles at the base, with a characteristic reddish-yellow triangular blotch clouded with black in the centre of the wing.

Guérin says:—"This curious species will probably become the type of a new genus, on account of the singular projection on its head, which does not resemble the horns of the male *Ceratitis*. However, we have not judged it necessary to establish one for a single species of which we have only one specimen, and have, therefore, placed it in the genus *Ceratitis*, to which it shows the most characters. In case it is judged necessary to separate that insect generally, we propose to give to that group the name of *Lenophila* (*lenos*, fruit; *philos*, I love). Head pale yellowish-red, very bright on the sides or the cheeks, a line beside the eyes, and the posterior part of the sides of the thorax pale yellowish-white. On each side of the vertex beside the eyes is a black blotch, which unites at the back with a larger blotch on the

posterior side of the head; the space occupied by the ocelli very black; the ocelli very prominent, reddish-brown. The front of the epistome black with pale reddish sides; the antennæ pale reddish-yellow, like the front of the head, the bristles brown, and slightly downy. In the middle of the face, immediately below the insertion of the antennæ, is a sort of horn or membraneous plate, smaller than the surface, compressed between the eyes, almost square in form, turned up at the anterior edge, and of a pale reddish-yellow colour. The exposed part of the palpi is pale red, and the horn blackish-brown. The thorax is of a uniform shining black, but ought to have had blotches or grey lines, for one still perceives some traces of grey hairs on the less exposed parts. The scutellum very large, globular, and rounded like the other species of *Ceratitis*, but without blotches; the sides of the dorsal surface shining black, and show, by the remains of fine hairs, that they have, perhaps, been thus clothed when the insect was fresh. The wings hyaline, with blackish nervures; those at the base are widened, with their spaces marked with blotches and little black lines as one sees only in the *Ceratitis*; beyond the spotted area and little before the middle, there is a large transverse band of blackish-brown, bent at the side, and carrying a second oblique band, which just reaches the lower margin, between the first band and the summit of the wing; there is, further at extreme tip of the wing, a brown band which parts from two-thirds the length of the wing and along the upper edge to the extremity. The abdomen is triangular, of a bluish-black tint, with transverse bands of soft grey hairs. Legs brown, with the knees and the first two or three joints of the tarsi yellow; the hind legs thick at the base, without spines on the inside of the external extremity, with two large tubercules or rounded teeth.

This specimen of the male sex is 6½ millimetres in length. It has been given to us as coming from Port Jackson, New Holland (now Sydney, New South Wales).

The Mauritius Fruit Fly.

Ceratitis catoirei, Guérin.

(Rev. Zool., 1843, p. 197.)

In a paper entitled a "Monograph d'un Gene de Muscides nommè *Ceratitis*," Guérin describes all the known species of the genus at that date, and adds several new species, among which is this species. The following is a translation of Guérin's description:—

"Head antennæ and face of a pale yellow colour, the horn (spatulate tipped bristle?) of the male inserted at the anterior extremity of a little oblong tubercle near the eyes, a little longer than the head, and terminating into a spatulate process of a triangular shape, or truncate at the tip. Thorax black, shining on the dorsal surface, with fine white-grey transverse ridges above on the front edge, formed of a very fine close pubescence broken into the middle, with two large black spots, showing on the other hand near the hind margin a transverse line and trident-shaped mark of golden yellow. Scutellum shining black, globular, ornamented near the base with a line like the preceding one, but much deeper and sinuous; posterior edge of the metathorax below the scutellum covered with lines of fine white silvery pubescence. Wings hyaline, with a slight touch of yellow on the nervures, the points black at the base; a large transverse yellow band edged with blackish, side by side, and stained with black spots from the middle to the tip, and from the side of the inner edge a brown band goes obliquely towards the side, and then

banding before reaching there, in order to reunite at the middle of the band; between it and the costal band there is a little patch of the same colour more bruised and mottled.

Abdomen of a very bright yellow, with the base and posterior edge of the first segment and the posterior half of the third segment silvery white, produced by a very fine silvery pubescence. Legs, bright yellow, hairy; the forelegs fringed with fine hairs, yellow, almost orange.

In the female the vertex is pale yellow, slightly brighter than the front part of the head; the extremities of two slight tubercles, which are near the eyes, carry a strong spiny-black bristle, resembling the other stout bristles on the head in both sexes. The wings resemble those of the male, but have the brown blotches more pronounced.

Length—Male, 5 to 6 mm.; female, 6–7 mm.

Habitat—Mauritius.

There is a specimen of a male under the name of *Ceratitis catoirei* in the Verrall Collection determined by Bigot that I examined, which has the abdomen more silvery than *C. capitata*, and has the spatulate tipped bristles on the forehead well developed, but the terminal tips, instead of being diamond-shape, were truncate at the tips.

Habitat—Isles Bourbon and Mauritius.

This species was first collected by Mr. Cattoire on the Isle de France (Mauritius). He sent them to several entomologists and to W. S. Macleay, who confounded them with the species he described as *C. citriperda*. Guèrin-Méneville, however, obtained several specimens, and among them some males, which decided him that it was a distinct species, so he named it after the discoverer. Macleay spells the name *Cattoire*, but Guèrin spells it *Catoire*.

Ceratitis (?) *penicillata*, Bigot.

(Annals Soc. Ent., France, Vol. XL., p. 308, 1891.)

"Length, 4 mm. Male. Antennæ incomplete."

Notwithstanding the mutilation of the antennæ and the absence, probably accidental, of the frontal appendages, the face and other characters seem to demonstrate that this insect is certainly a *Ceratitis*, so that it seems best to consider it the type of a new species.

Basal segments of the antennæ pale red (the third wanting), face front and cheeks whitish; a large brown quadrangular spot on the epistome. Thorax whitish-grey, marked with four indistinct brownish lines; scutellum whitish, marked at the posterior edge with three black shining points; abdomen greyish-white with the base of the segments blackish, halteres whitish. The first two pair of legs yellowish-white, the apex of the thighs of the forelegs brown, with the thighs on the upper surface clothed with some incurved black bristles in the second pair of legs, the middle of the thighs, and the extremity of the tibiæ lightly stained with brown; the hind legs of the same colour as the middle legs, but have the tibiæ fringed inwardly to the extremity with some long stiff black bristles a little flattened and dense. The wings are whitish, with some black points showing at the base, and five others disposed along the fourth and fifth longitudinal nervures, the wings further ornamented with four large reddish transverse bands, the first near to the base, the second through the middle, the third longitudinal to the outer edge and joining the second, to touch the other part, the tip of the wing; the fourth and last placed on the second transverse nervure and extending to the edge, until a little beyond the nervure.

The Natal Fruit Fly.

(Pl. V, fig. 19.)

Ceratitis rubivora, Coquillet.

(Proceedings of the U.S. National Museum, Vol. XXIV, p. 29, No. 1,243, 1901.)

"Head yellowish, a grey spot streaked with black above the neck and sending a wide stripe to each eye, a black ocellar dot; mouth parts and antennæ yellow, the arista short plumose, brown, the base yellow, antennæ three-fourths as long as the face, front in both sexes bearing only normal bristles, thorax yellowish-brown, largely greyish pruinose, mesonotum marked on each side with a broad, interrupted, black, polished stripe and with three narrow, indistinct, black, median lines which at their posterior ends expand so as to meet each other; between this point and the scutellum is a transverse pair of polished, whitish spots, humeri whitish, upper part of mesopleura yellow; scutellum yellow, the outer margin marked with three black spots, metonotum polished black, crossed in the middle by a broad transverse, opaque, greyish pruinose fascia emarginate in the middle of the lower edge, two yellow spots on each side of the metathorax; abdomen yellowish, the third and fifth segments, except a large triangular spot in the middle of each, black; wings hyaline, a brown cross-band on a line with the humeral cross-vein, followed by about ten brown dots, a second brown cross-band, yellowish in the vicinity of the small cross-vein, extends from the costa beyond apex of auxiliary vein to apex of the sixth, including the small cross-vein in its outer portion; a brown stripe, yellowish in the central part, extends close to the costa from beyond apex of first vein to beyond apex of the third, its margins marked with four or five darker brown dots; an elongated, oblique, brown spot on the fourth vein before its apex, and a larger one bordering the hind cross vein: legs yellow, in the male the front femora marked with a black streak on the upper and another on the posterior side, middle femora on the broad apex, except a streak on the anterior side and the extreme apex, black; hind femora with a black spot before apex of under side prolonged as a streak in the middle of the anterior side; middle tibiæ, except the extreme ends, black; in the male the under side of middle femora on the apical half, also the inner and outer sides of the middle tibiæ, densely fringed with long flattened bristles; halteres yellowish; ovipositor of female greatly flattened, the basal piece as long as the last two abdominal segments. Length, 4 to 5 mm.

Type in the United States National Museum. Specimens collected at Wynberg, Cape Colony, South Africa.

Specimens of this fruit-fly were sent to Coquillet by C. P. Lounsbury, from Cape Colony, to be identified, or described if new. He returned the co-types to Mr. Lounsbury, who has very kindly presented me with specimens.

This fly is about the same size as *Ceratatis capitata*, but of a general lighter brown tint; the dark markings on the dorsal surface of the thorax wanting, or only showing faint traces on the hind half; while the scutellum is very prominent with a large square black mark in the centre, and a smaller rounded one on either side. The apex of the thorax is more silvery, and the two bands round the abdomen are more grey than mauve. The

stout black bristles on the head and thorax are much more numerous, and the wings are somewhat different, as will be seen on comparing the drawings on plate 5.

The curious spatulate face appendages are not present in the male of this species.

From the description and figures given by Fuller in his First Report of the Government Entomologist of Natal, 1899–1900, page 70, and Second Report, 1901, page 20, it is evident that this is the common species in Natal, though in his report it is identified as *Ceratitis corysa*, Walker. According to Von Röder the species described by Walker as *Trypeta cosyra* is identical with our *Ceratitis capitata*, so that Coquillet's name will stand. Fuller says: "This insect ranks a good first among fruit-pests of Natal. It is impossible to say whether it is an introduction into the country or not. It has been known upon the coast belt as far back, I believe, as old colonists can remember, and is simply credited by them with being worse nowadays than then. It is only during the last twenty to thirty years, however, that it has been known at Maritzburg. It ranges up the coast about 150 miles, and is said to be spreading all over the colony. It infests all kinds of cultivated fruits, and several native wild fruits."

NOTE.—Lounsbury since tells me that he does not consider these species identical; and also that while *C. rubivora* is only bred from blackberries, *C. corysa* infests all fruits.

Ceratatis lycii, Coquillet.

(Proceedings of the U.S. National Museum, Vol. XXIV, p. 30, No. 1,243, 1901.)

"Head yellow, a black spot above the neck, sending a branch to each eye, a black spot in the middle of upper part of face; antennæ yellow, three-fourths as long as the face, proboscis brown, the palpi yellow, body black, mesonotum opaque greyish pruinose, the margin produced inward at the front and hind angles, and in the middle in front, also a pair of round dots behind the suture, polished; a spot on the humerus uniting with a broad stripe on upper edge of pleura, also a sinuous, interrupted line at base of scutellum, light yellowish; abdomen polished, the posterior portion of the first and third segments opaque, whitish pruinose, remainder of third segment opaque, brownish pruinose; ovipositor flat beneath, convex above, the basal portion as long as the last two abdominal segments; wings hyaline, a broad brown cross-band in a line with humeral cross-vein, followed by three or four longitudinal brown streaks and about nine brown dots, a second brown cross-band extends from beyond apex of auxiliary vein to apex of last vein, at the costa united with a broad brown stripe that extends along the costa to midway between apices of third and fourth veins, filling the costal margin to the third vein, and near middle of last section of the latter, sending a branch obliquely to the wing margin below apex of fourth vein; the second cross-band also sends a branch from the small cross-vein obliquely to the apex of fifth vein, covering the hind cross-vein; the costal margin is very narrowly hyaline between apices of the first and third veins, except a pair of brown dots between apices of first and second veins; extreme base of wings yellowish; legs, including the front coxæ, yellow. Length, 4 mm." Type in the United States National Museum (No. 5,791). Described from specimens from Cape Colony, South Africa.

Ceratitis rosa, Karsch.

(Entomologische Nachrichten, Vol. XIII, p. 22, 1887.)

"Shining black, with brownish-yellow hairs; thorax with two shining black spots on the subdorsal sides; the sides of the sternum yellow; scutellum shining black, transversal line on the base and four longitudinal lines dull orange yellow, with transverse lines on the abdomen; with shining black spot on the dull yellow face, antennæ and legs yellow, the tibia of the mid legs clothed with fine bluish-black scale-like hairs along the edges."

Length, 5 mm. Habitat—Delagoa Bay, Africa.

At Mr. G. H. Verrall's, when examining the Bigot Collection, I found one specimen under this name which had the body much lighter coloured than in *C. capitata*, the wings much more spotted along the costal margin, the black coloration on the scutellum forming four black spots. It was labelled Natal, South Africa, and appeared to be distinct from *C. rubivora* of Coquillet.

Ceratitis striata, n. sp.

(Pl. V., fig. 17.)

Length, 5 to 6 mm. General colour pale yellow to greyish, with the upper surface of the thorax variegated with black. Wings hyaline, marked with fine black lines and spots on the basal portion, with a broad parallel dull yellow band along the costa from the apex of the black markings, and curving well round the apex of the wing; from this run two broad and one narrow irregular transverse bands crossing the wing, so that with the curve of the tip it appears to have four transverse bars; both the parallel stripe and transverse bands slightly clouded with fuscous. Head of male without the curious spatulate tipped hairs of *C. capitata*, eyes dark, face unspotted but lightly marked with brown above the antennæ, a dark spot on the summit, clothed with coarse scattered black bristles. Thorax elongate, stained with chestnut brown in front on dorsal surface, the rest greyish, with the shining black areas not so compact as in *C. capitata*, and forming three very irregular black parallel bars, the outer ones thickest; the scutellum shining black, slightly mottled behind, and below it on the apex of the thorax black; the whole of the thorax lightly clothed with stout black bristles, of which two long ones spring out from the hind edge of the scutellum; the legs pale yellow, with stout spine-like hairs on the femora and rows of very fine short spines down the angles of the tibiæ. Abdomen broadly rounded in the male, that of the female produced into a long pointed sheath at the anal segment; greyish, very indistinctly banded, covered with fine hairs, with a few scattered bristles, forming a tuft of four or five at the tip. Habitat. Peradenyia Gardens, Ceylon.

When examining the insect collections of Mr. E. E. Green, Government Entomologist at the Royal Botanic Gardens at Peradenyia, I came across a series of fruit-flies with No. 1,466 attached to them, and on Mr. West turning up the records we found the following note under this number:—"Bred from the decaying shoots of bamboo, Peradenyia, 1903." There was a fine series of both male and female specimens, though somewhat mouldy.

I propose the name *striata* on account of the black markings on the thorax forming irregular bands, and also the markings on the basal portion of the wings being more striate than spotted.

The Baluchistan Melon Fly.

Carpomyia pardalina, Bigot.

(Indian Museum Notes, Vol. II, No. 7, 1891–93, p. 51.)

This curious fly, which is very closely allied to the Mediterranean fruit-fly, was discovered and bred by Mr. J. Cleghorn, who found them in Peshin at an elevation of 5,000 feet, where they were infesting the young melons and were most injurious toward the end of summer. He gives a very interesting account ("Miscellaneous Notes, Indian Museum," page 24, vol. II) of its life history, and says he is of opinion that the hard winters kill the majority of the hibernating pupæ, so that it is after a mild winter that the insect is chiefly abundant.

The following is a translation of Bigot's technical description of this fly, specimens of which I examined in the Calcutta Museum:—"Length, male 4½ mm., female 5½ mm. with the ovipositor. Eyes brilliant, bronzy green; head with antennæ, proboscis, and palpi pale fawn colour, long bristles, blackish, the antennal bristle black with white at the base. Thorax pale fawn, front of the thorax with two very narrow reddish lines, behind whitish, with four large shiny black rounded projecting spots on each side of the dorsal surface; the scutellum with three large spots situated on the side, and one small median blotch all alike; the long bristles black; legs pale fawn colour, thighs of forelegs rather thickened, with several brownish hairs beneath. Abdomen pale fawn colour, the base of the segments greyish, brown. Wings hyaline, with three large fawn transverse bands, the one at the extremity divided into a V, of which the outward branch turns round the tip of the wing; all the margins of the bands greyish, particularly the one at the tip of the wing.

"Female resembling the male, with the ovipositor reddish, short, and blunt."

According to Maxwell Lefroy ("Indian Insect Pests," 1906), its life history has been worked out in the Report of Lala Vishwa, Entomological Assistant, Punjab.

Genus—TRYPETA, Meigon.

(Illigers Magazin, Vol. II, p. 277, 1803.)

This genus contains a number of very handsome flies remarkable for the rich coloration of their wings and bright-coloured eyes. In many species they have the body clothed with scattered more or less stout blackish bristles, and very little pubescence. The larvæ live in vegetable matter, the female by means of her pointed ovipositor depositing her eggs in the tissue of the plant, and a number of them produce curious galls. There are a number of species peculiar to Australia, and two species are known as fruit pests.

The Mexican Fruit Fly.

(Pl. III, fig. 12.)

Trypeta ludens, Loew.

(Monograph of the Diptera of North America. Part III. Smithsonian Misc. Coll., No. 256. Washington, 1873, p. 223, Pl. 11, fig. 19.)

This fruit-fly was known many years ago among the Mexican fruit-growers as an orchard pest, attacking the orange, mango, guava, and other fruits. It appears to be a native of Mexico, but its exact home has never been decided.

Until the growing of oranges became a profitable industry and an export trade sprang up in the United States, little or no notice was taken of its

presence. In 1897, Dr. L. O. Howard, in the Year-book of the United States Department of Agriculture, called the attention of the American orchardists to the danger of introducing such a serious pest into the orange orchards of California with infested fruit. The result was, that in 1900 the Commissioner of the State Board of Horticulture in California brought an Act into existence prohibiting the importation of Mexican oranges into California, in consequence of having found infested oranges in their State, shipped from the port of Acupulco; and he gave instructions that any consignments coming from any part of Mexico should at once be destroyed. This action raised a storm of indignation among the Mexican growers and their Government; the former declared that it was simply a case of protection of the home market for the Californian orchardists.

In 1905, Mr. John Isaacs was sent by the Governor of California to investigate the range and state of the fruit-fly in Mexico, and accompanied by Professor A. S. Herrera (Commissioner de Parasitologia), he visited all the chief centres of the orange industry. His report on the Mexican Orange Worm (*Trypeta ludens*), with many illustrations, and a map of the infested States, was published by the State Board of Horticulture in California on his return. The restrictions as regards California were not removed, but the Mexican oranges were allowed admission into the Eastern States, though the high protective tariff on oranges imposed by the United States Customs makes it almost prohibitive.

This was one of the fruit-flies that I was particularly anxious to see and investigate, as it was an orange pest in the first instance, though, like most fruit-flies, it incidentally infests other fruit when numerous.

On my arrival in Mexico, the first thing I did was to see the authorities at the Department of Agriculture, examine all their specimens, and obtain all the information they had regarding their habits, range, and the methods enforced to keep them in check. Through the kindness of Professor A. S. Herrera, Chief of the Bureau de Parasitologia, and Dr. Giandra, the Pathologist, I obtained much valuable information. Both these gentlemen were very emphatic regarding the uselessness of the parasite (*Cratosipla rudibunda*), which was figured and described in the Californian Report, as a check upon this fly. I had previously received specimens of this little red wasp from Professor Koebele, which he had bred from infested mangoes from the Mexican market the year before.

This fruit-fly, about 4½ lines in length, is of a general dull ochreous yellow colour, with large hyaline wings mottled and striped with brownish-yellow bands, forming a very irregular pattern, as seen in the figure of the wing given. The female is remarkable for the great elongation of the anal segment of the abdomen, which is considerably longer than the rest of the abdominal segments combined. As far as I know, it is not recorded from any other country, but has an extended range over the fruit-growing districts of Mexico.

The Island Fruit-fly.

(Pl. VII, figs. 1, 2, and 3*a*.)

Trypeta musæ, Froggatt.

(*Agricultural Gazette, N.S.W.*, June, 1899, p. 501, Pl. II, figs. 1 and 2. Miscellaneous Publications Dep. Agriculture, N.S.W., No. 303.)

In the original description the numbers on the plate were transposed, but the species are very distinct.

The maggots of this fly were on several occasions obtained from condemned bananas coming in shipments of fruit from the New Hebrides. The maggots are easily distinguished from the Queensland species by the different colour and form of the anal respiratory tubes, which are black and small at the orifice. The fully-developed maggot is larger, and of a darker colour, the pupæ lighter yellow, and somewhat more rounded in form.

Within the last few years this species has been introduced into Queensland, where it is quite common in cultivated fruit; and last year (1908) Mr. Gurney bred quite a number in the Gosford district from various fruits.

It is allied to *Trypeta bicolor*, Macq., a species peculiar to Australia, and which I have collected on the wing in the Bathurst district, New South Wales; but it is a much lighter-coloured fly, with the wings more lightly clouded.

This fly measures three lines in length, and has a wing expanse of six lines. The head is small, ochreous, with dark eyes, and the whole of the upper surface covered with stout, black bristles, which extend over the dorsal surface of the thorax; the antennæ yellow, with a long bristle standing out from the apex of the second joint, the terminal joint short and rounded. The thorax is brownish yellow, rounded in front, broad to the base of the wings, and sloping round to the scutellum, which is rounded in front, produced into a spine on either side of the hind margin. The legs lightish-brown, with the tarsal spines, claws, and tibial spines of the hind legs black. Wings hyaline at base, with all the upper half black to dark brown, with an irregular hyaline blotch on the costal nervure extending to the subcostal cell; two small, rounded, hyaline spots on each side below, and mottle-brown clouding in the lower cells. The abdomen is small, light brown at base, black on the apical half, covered with coarse hairs.

Habitat—New Hebrides, Queensland, and New South Wales.

NOTE.—Through the experiments carried out at Narara by Mr. Gurney it has been discovered that this fly breeds in the native fruits in that district, and is particularly abundant in the "Black Apple" (*Achris australe*). Within the last month (February) I have bred it from the same wild fruit collected at Thirroul, south of Sydney, so that it has a wide range along the coast. It is also very doubtful if this species ever punctures perfectly sound orchard fruit. All the evidence gained by Mr. Gurney and myself after close observation in the orchard for the last six months, tends to the conclusion that unless a fruit has a bruise, blemish, or has been previously punctured by some other insect, it is not touched by the Island Fruit-fly.

The Apple Maggot.

(Pl. VIII, figs. 1, 2, and 3.)

Rhagoletes (*Trypeta*) *pomonella*, Walsh.

(American Journal of Horticulture, December, 1867, p. 338.)

This is a well-known apple pest in the eastern portion of the United States and Canada wherever apples are grown, and among the orchardists is popularly known as the "Railroad Worm," on account of the regular winding tracks it makes when eating its way through the tissue of the infested apple. It is a native of North America, and its original food was the wild haws, and, probably, crab apples, so that the cultivated apple is an acquired habit,

It has been recorded from England, to which country it has probably been introduced with fruit from America, but is hardly a pest in the former country.

Nearly all the writers upon economic entomology in North America have written upon this pest. In the Annual Report of Maine Agricultural Experiment Station, 1890, Professor L. F. Harvey gives the results of his investigations into its life history in the years 1888–9. In the Report of the Experimental Farms at Ottawa, 1898, Dr. James Fletcher says that it is a serious pest in Canada; and in the State of Vermont as much as half the crop is often destroyed.

In Circular No. 101 of the United States Bureau of Entomology (1908), A. L. Quaintance gives a very interesting account of this apple pest in the United States, where he compiles all the latest information about its spread and the damage caused by its ravages.

Description of perfect fly: Length of body, 2½ lines; expanse of wings, 4 lines. The eyes are black, with the antennæ, face, forelegs, and the tibiæ and tarsi of the hind legs ochreous. The thorax is black, with white markings on the sides of the prothorax, beneath the wings, and the scutellum white; the centre of the thorax clothed with grey pubescence; the head and thorax covered with stout, scattered bristles; the thighs and base of tibiæ of the fore and hind pair of legs black. The hyaline wings are deeply banded with oblique transverse bands of black; the black abdomen covered with fine hairs, which form grey bands along the apical margin of each segment.

Sydney: William Applegate Gullick, Government Printer.—1909.

DESCRIPTION OF PLATES OF WINGS OF FRUIT FLIES, AND OTHER DETAILS.

PLATE I.

Fig. 1. *Dacus tryoni*, Froggatt, Queensland.
Fig. 2. ,, *oleæ*, Rossi, Southern Europe.
Fig. 3. ,, *xanthodes*, Brown, Fiji.
Fig. 4. ,, *Frenchi*, n.sp., New Caledonia.

PLATE II.

Fig. 5. *Dacus persicæ*, Bigot, India.
Fig. 6. ,, *cucurbitæ*, Coq., India.
Fig. 7. ,, *cucurbitæ*, Coq., Hawaii.
Fig. 8. ,, *ferrugineus*, Fab., India.

PLATE III.

Fig. 9. *Dacus immaculata*, Coq., S. Africa.
Fig. 10. ,, *lounsburyi*, Coq., S. Africa.
Fig. 11. ,, *æqualis*, Coq., N. S. Wales.
Fig. 12. *Trypeta ludens*, Loew., Mexico.

PLATE IV.

Fig. 13. *Dacus ornatissimus*, n.sp., Fiji.
Fig. 14. Showing markings on thorax and abdomen
Fig. 15. *Dacus curvipennis*, n.sp., New Caledonia.
Fig. 16. Showing markings on thorax and abdomen.

PLATE V.

Fig. 17. *Ceratitis striata*, n.sp., Ceylon.
Fig. 18. ,, *capitata*, Wied., Australia.
Fig. 19. ,, *rubivora*, Coq., S. Africa.

PLATE VI.

Life History of the Queensland Fruit Fly, *Dacus tryoni*, Froggatt.

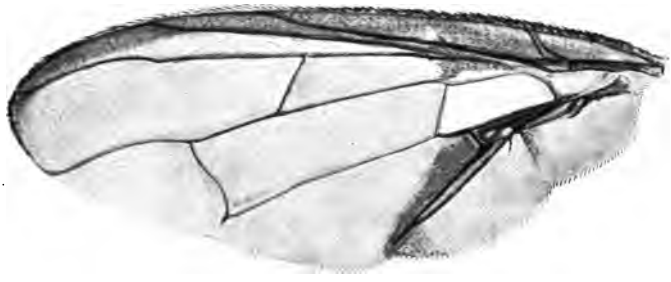
Fig. 1. Perfect fly viewed from above.
Fig. 1*a*. Natural size.
Fig. 3. Larva magnified 5 times.
Fig. 4. Pupa, magnified 7 times.
Fig. 5. Mouth hooks of larva (much enlarged).
Fig. 6. Mouth parts (underside).
Fig. 7. Anal segment (magnified).
Fig. 8. Tubercle, under surface of anal segment (magnified).

PLATE VII.

Fig. 1. *Trypeta musæ*, Froggatt (side view).
Fig. 2. ,, ,, ,, (dorsal view).
Fig. 3. ,, ,, ,, (natural size).
Fig. 1*a*. *Dacus psidii*, Froggatt (dorsal view).
Fig. 2*a*. ,, ,, ,, (side view).
Fig. 3*a*. ,, ,, ,, (wing).
Fig. 4*a*. ,, ,, ,, (natural size).

PLATE VIII.

Fig. 1. *Rhagoletes* (*Trypeta*) *pomonella*, Walsh (side view).
Fig. 2. ,, ,, ,, ,, (dorsal view).
Fig. 3. ,, ,, ,, ,, (natural size).
Fig. 1*a*. *Ceratitis capitata*, Wied. (dorsal view).
Fig. 2*a*. ,, ,, ,, male (side view).
Fig. 3*a*. Wing.
Fig. 4*a*. Natural size.



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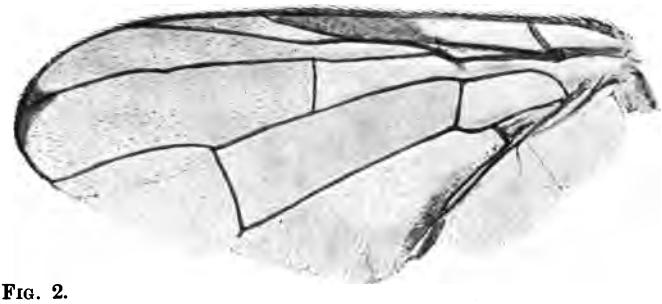

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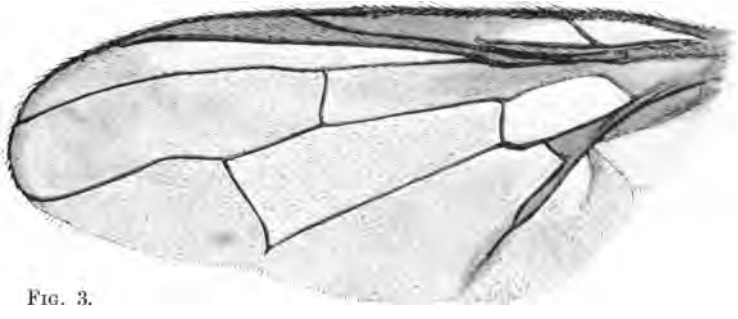
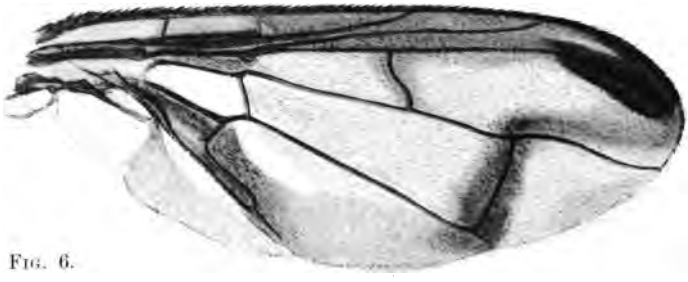


FIG. 3.

FIG. 4.

FIG. 5.



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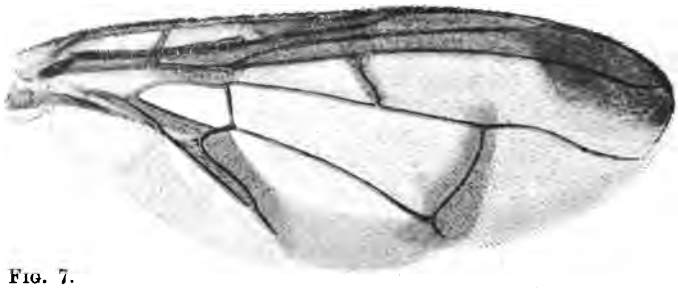

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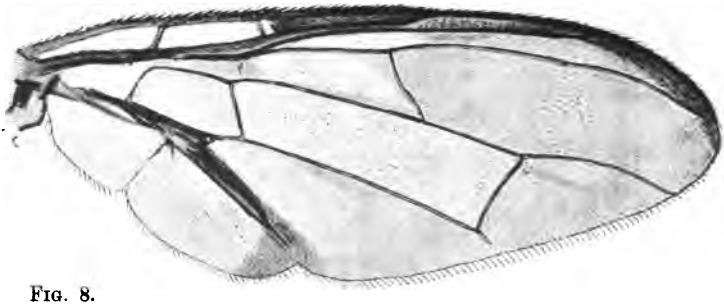

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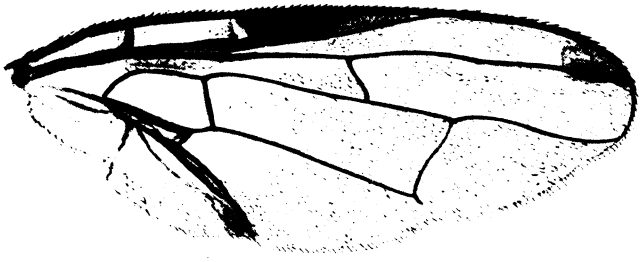

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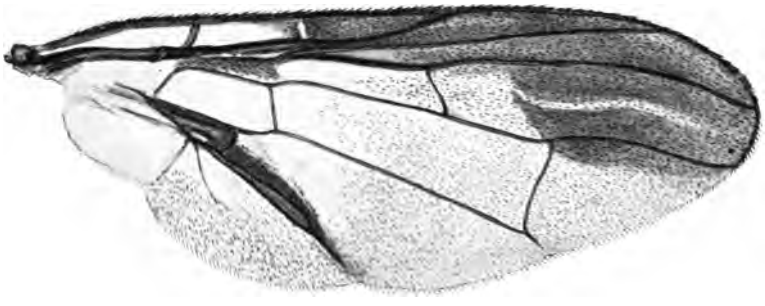

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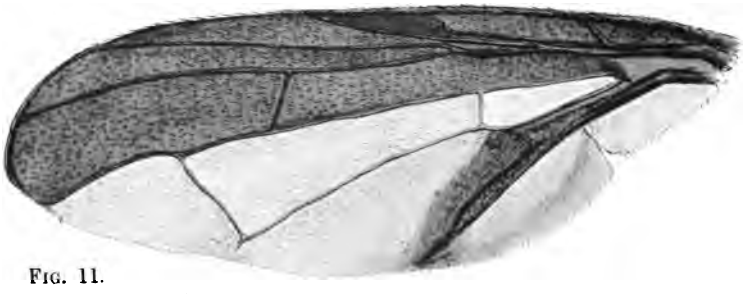

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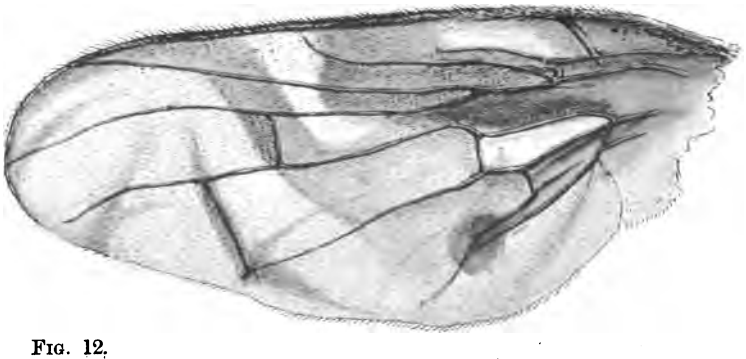

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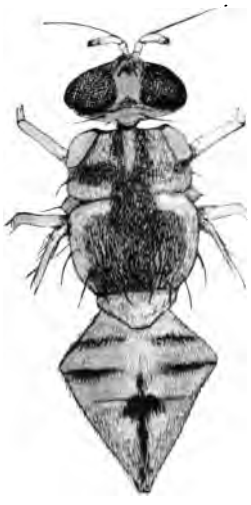

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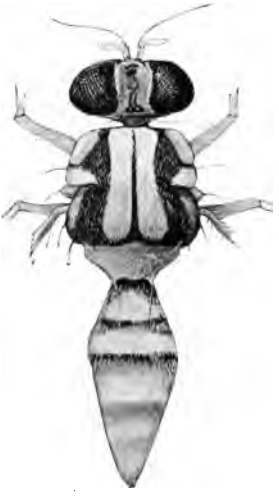

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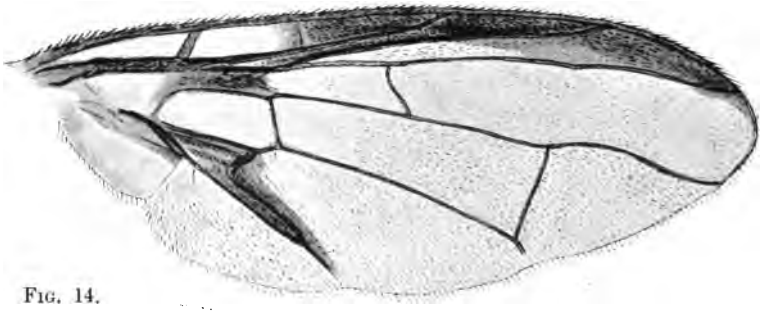

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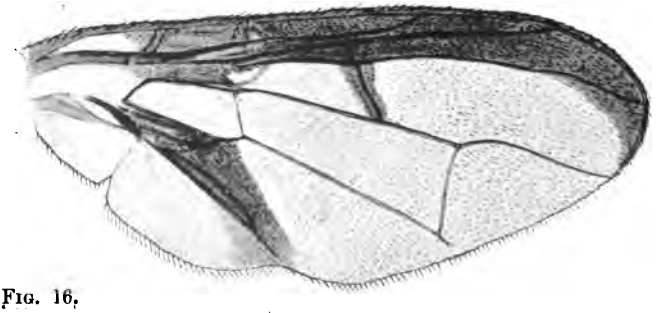

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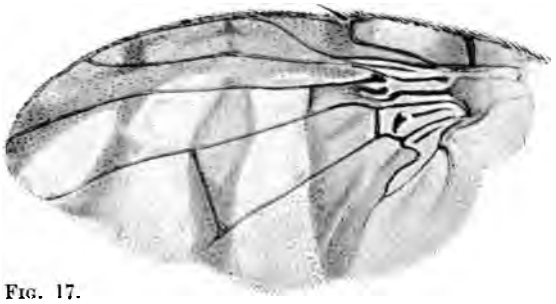

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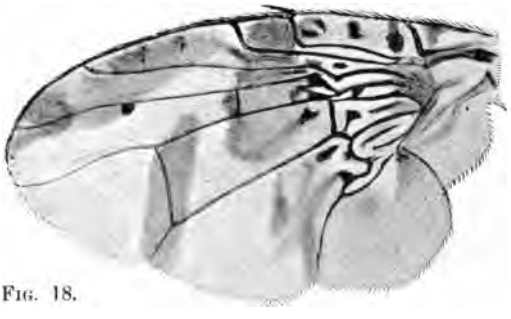

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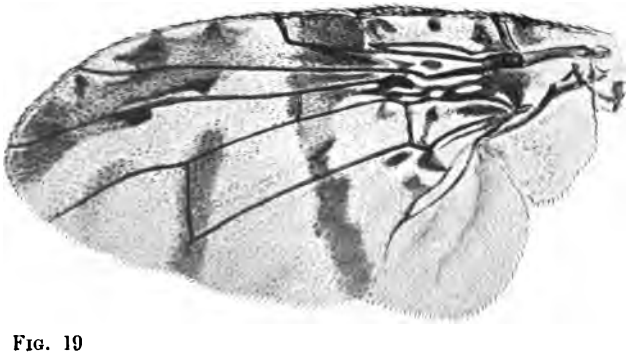
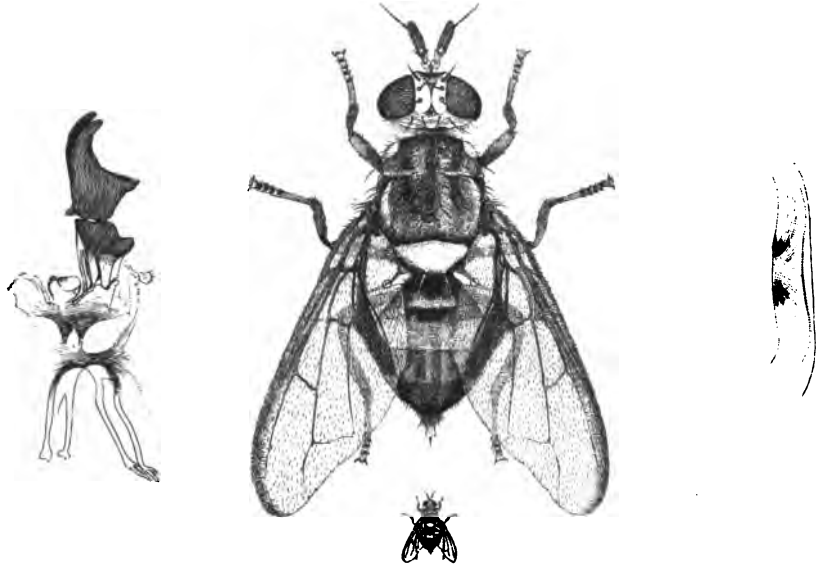
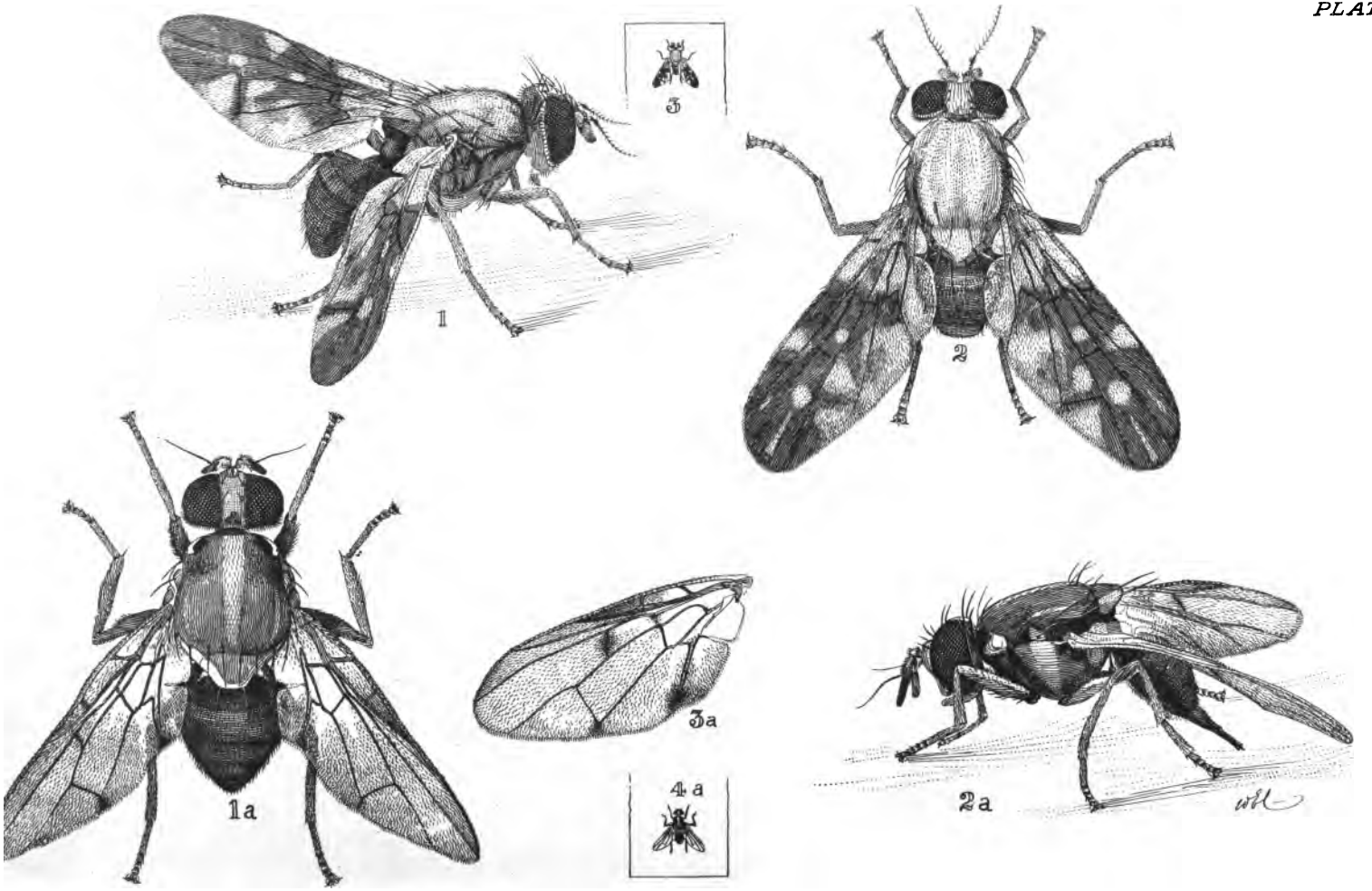


FIG. 19



QUEENSLAND FRUIT-FLY.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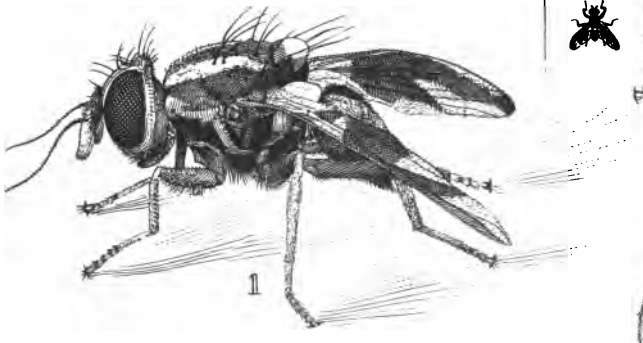
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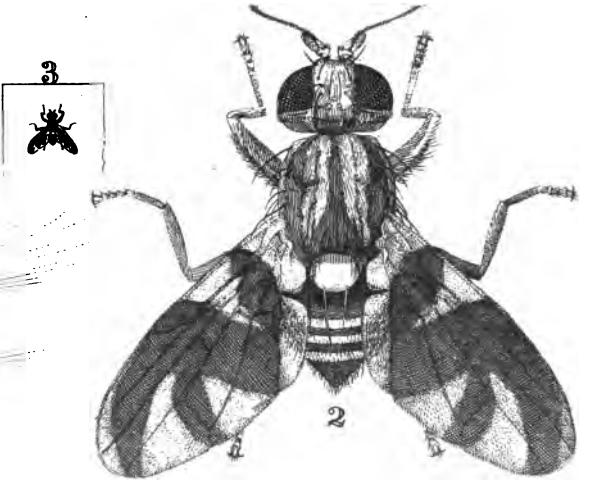
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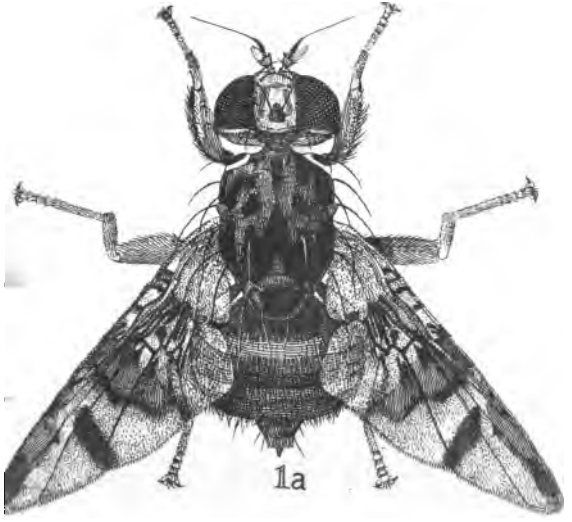
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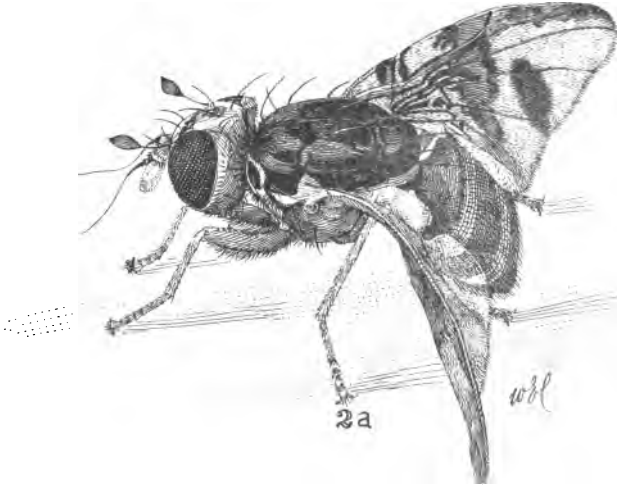
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